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Production and Export of CORN and RICE in **BRAZIL**



PROSPECTS FOR THE 1970's



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PRODUCTION AND EXPORT OF CORN AND RICE IN

BRAZIL--PROSPECTS FOR THE 1970's

By

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Technical Assistance Team

to

Brazil

in cooperation with the

Agency for International Development

FOREWORD

To provide better knowledge for planning and implementing programs in developing countries, the Agency for International Development (AID) has asked the Economic Research Service (ERS) of the U.S. Department of Agriculture to provide agricultural economists to serve on U.S. Department of Agriculture Participating Agency Service Agreement (USDA/PASA) teams. Such teams support the AID agricultural objectives for the host developing country.

The ERS economists serve mainly as technical consultants to national or central agencies of the host country, such as the Ministry of Agriculture, and to the AID Missions. They provide technical assistance, guidance, and training to improve the technical competence and skills of the host country's counterparts in dealing with institution building of the developing country.

This report presents the results of an analysis prepared while the author was stationed in Brazil on a USDA/PASA team. The analysis was completed mainly between July and October of 1968 from information and materials as were available with only limited new field work. It was prepared within the context of cooperation among several agencies of the Governments of Brazil and the United States. Accordingly, consistent with self-help objectives, a modified draft is concurrently being readied for publication in Portuguese, with the collaboration of Dr. Carlos Cayres Leite Ribeiro of the Ministry of Agriculture's Office of Statistics and Economic Analysis (ESCO).

In addition to describing the seven regional commercial production areas of corn and rice, the report gives detailed attention to factors affecting the prospects for production and exports in the 1975-76 period and issues involved in expanding corn and rice production and exports. Many of the choices arising from these factors involve political as well as economic considerations. Much emphasis has been placed on the characteristics and circumstances of the farm operating unit since that is where the primary decisions about production and marketing are made.

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SUMMARY

Corn and rice together account for approximately 40 percent of the total crop area in Brazil. Brazil is a relatively low-cost producer of both cereals, with large reserves of land where production can be expanded through larger plantings and more intensive practices. Production over a number of years has been expanding at a rate which more or less parallels the growth of domestic demand.

Exports have seldom exceeded 5 percent of annual production for either corn or rice. Exporting was intermittent before 1963 but has since become a normal practice. With Brazil's share of the world coffee market tending to decline, and with serious limitations to export potentials for sugar, cocoa beans, and manufactured goods, attention has turned to other products, including corn and rice, as possible sources of increased export earnings.

There is reason to believe Brazil is capable of increasing her corn and rice exports at annual rates of 1.5 and 0.8 million tons, respectively, by 1975-76, while continuing to expand aggregate agricultural production at a rate more or less proportional to the growth of domestic demand. On this basis, corn and rice exports in 1975-76 would be nearly three times as large as in 1965-66.

These projections (proposed here as reasonable, but not intended as either forecasts or recommended goals) imply gains from 1965-66 of 54 percent in total corn production and 56 percent in total rice production. The percentage gains in production due to increases in area and yield per hectare are expected to be 33 percent and 15 percent, respectively, for corn and 41 percent and 10 percent for rice.

These data reflect the continuing importance of Brazil's large land reserves, which have been almost the sole source of increased agricultural output for decades, but they also suggest a turning to more intensive cultivation as an additional source of expanded output.

Very substantial private and public efforts will be required to attain the projected output. Decisions on key issues of public policy will greatly affect the extent to which the projections are actually realized. The major issues can be classified into six interrelated groups.

The first group includes issues related to maintaining a generally favorable economic climate. These issues involve decisions about (1) controlling inflation while maintaining incentives for expanded agricultural output; (2) resorting to transaction taxes to finance public programs while avoiding the resulting economic burdens on agricultural production and marketing; and (3) improving the minimum-price program in agriculture, as well as the regulations, services, and facilities for marketing in general.

The second group of issues arises from broad planning in the agricultural sector. Public agencies need to establish an appropriate institutional framework and provide for effective use of public resources available for agricultural development. However, there is serious doubt that public agencies can plan effectively on the level of individual production units.

Issues in the third group concern whether more emphasis should be given to the intensive approach (higher yields) or the extensive approach (increased acreage) for expanding agricultural output. Since the two approaches are not mutually exclusive, the problem is finding the most favorable balance between the two. That balance will affect the issues in group four, which relate to further improvement of rural credit programs. Both sets of issues are also related to the question of how far agricultural mechanization can be encouraged without seriously accentuating the unemployment problem of rural workers--the key issue in group five.

Finally, the sixth group concerns the problem of improving diets of low-income families. This, in some degree, involves a choice between using increased corn for export or for upgrading diets at home.

INTRODUCTION

The rapid growth of Brazil's industrial sector in the last few decades has brought significant achievements in import substitution and in satisfying the existing local market for consumer goods, but it has not yet produced the export earnings needed to supplement those accruing from the traditional export crops. With Brazil's share of the world coffee market tending to decline, and with serious limitations to the export potentials for sugar, cocoa beans, and manufactured goods, attention has turned to other products, including corn and rice, as possible sources of sharply increasing export earnings.

Corn and rice together account for approximately 40 percent of the total crop area in Brazil. Production of each crop has been sufficient to permit some exports in most years since 1960, but the volume of these exports has been rather erratic. In 1966, some 627,000 metric tons of corn and 289,000 metric tons of rice were exported, but the combined exports of both crops did not reach 100,000 metric tons in 1960, 1962, or 1964. Nevertheless, Brazil is a relatively low-cost producer of both cereals, with large areas of land where production could be expanded through larger plantings or more intensive practices.

Objectives

Given these circumstances, the purpose of this study is to analyze the prospects for corn and rice output over the next 5 to 10 years in Brazil's major commercial production areas. Production and export, of course, will be greatly influenced by policies adopted with respect to maintaining minimum prices, reducing costs of inputs, extending production credit, facilitating the flow of products through marketing channels, and supporting research and extension activities.

The first step will be to identify and characterize the areas that account for the bulk of Brazil's commercial production of corn and rice. For each area, recent production trends, general characteristics of farm organization and production techniques, and present marketing patterns will be discussed.

The next step will be to analyze certain factors that will influence production and export. And the final step will be to identify emerging policy issues and to sum up prospects for total production and for international trade.

Regional Distribution of Production

Although pioneer expeditions were entering and exploring much of west-central Brazil and the vast Amazon Basin as early as the 17th century, most

of the country's population and economic development has remained in a rather narrow band along the eastern and northeastern coastline where the first settlements were established. Probably as much as 85 to 90 percent of the total population and at least as large a share of all economic activity are within the 15 percent of the country extending 100 to 300 kilometers inland along the coastline between Pôrto Alegre in the south and São Luís in the north. Industrial production is even more highly concentrated along the east coast, mainly around São Paulo, Rio de Janeiro, and Belo Horizonte.

Although commercial output of cereals tends to be somewhat removed from the coastline, most corn and rice production is found in the south-central 20 percent of the country, largely in a band not much more than 500 kilometers wide extending from the Uruguayan border northward to the latitude of Brasília, D.F. (figures 1, 2 and 3). A separate area of significant commercial rice production is in the central part of the State of Maranhão, which ships much of its output to Fortaleza, Recife, and other cities of the Northeast.

Notwithstanding the many detailed local variations in physical and economic conditions affecting corn and rice production, it has seemed convenient in this study to divide the country into seven regional units, which differ only slightly from the five regions used by the Institute of Geography and Statistics (IBGE). For present purposes, IBGE's South and Northeast Regions will each be subdivided, forming Regions I and II and Regions V and VI, respectively; the North (Region VII) will remain unchanged. The "Triângulo" area of western Minas Gerais will be included with the Central West Region (Region III), rather than with the East (Region IV). Except for the latter variation, the regional units, as shown by the solid lines in the figures, are divided along State boundaries.

Although production statistics will be presented for the seven regional units, the accompanying analysis will deal to a considerable degree with the more restricted areas important for commercial production of rice and corn within each region (figure 3). Regions I, II, and III each have important commercial production areas for both corn and rice; a fourth area for corn occurs in Region IV and a fourth area for rice in Region VI. In no case is the commercial production area for either crop fully coextensive with the regional unit, but this should cause no confusion since the commercial areas, as outlined in figure 3, account for a generally high proportion of the total output of their respective regions.

Throughout most of the last 15 years, Regions I, II and III have accounted for more than 70 percent of Brazil's corn and rice production (table 1). ^{1/} Production in most of the rest of the country is either of a subsistence nature or for consumption in local market areas, except for some of the corn and rice produced in Region IV and the rice produced in central Maranhão.

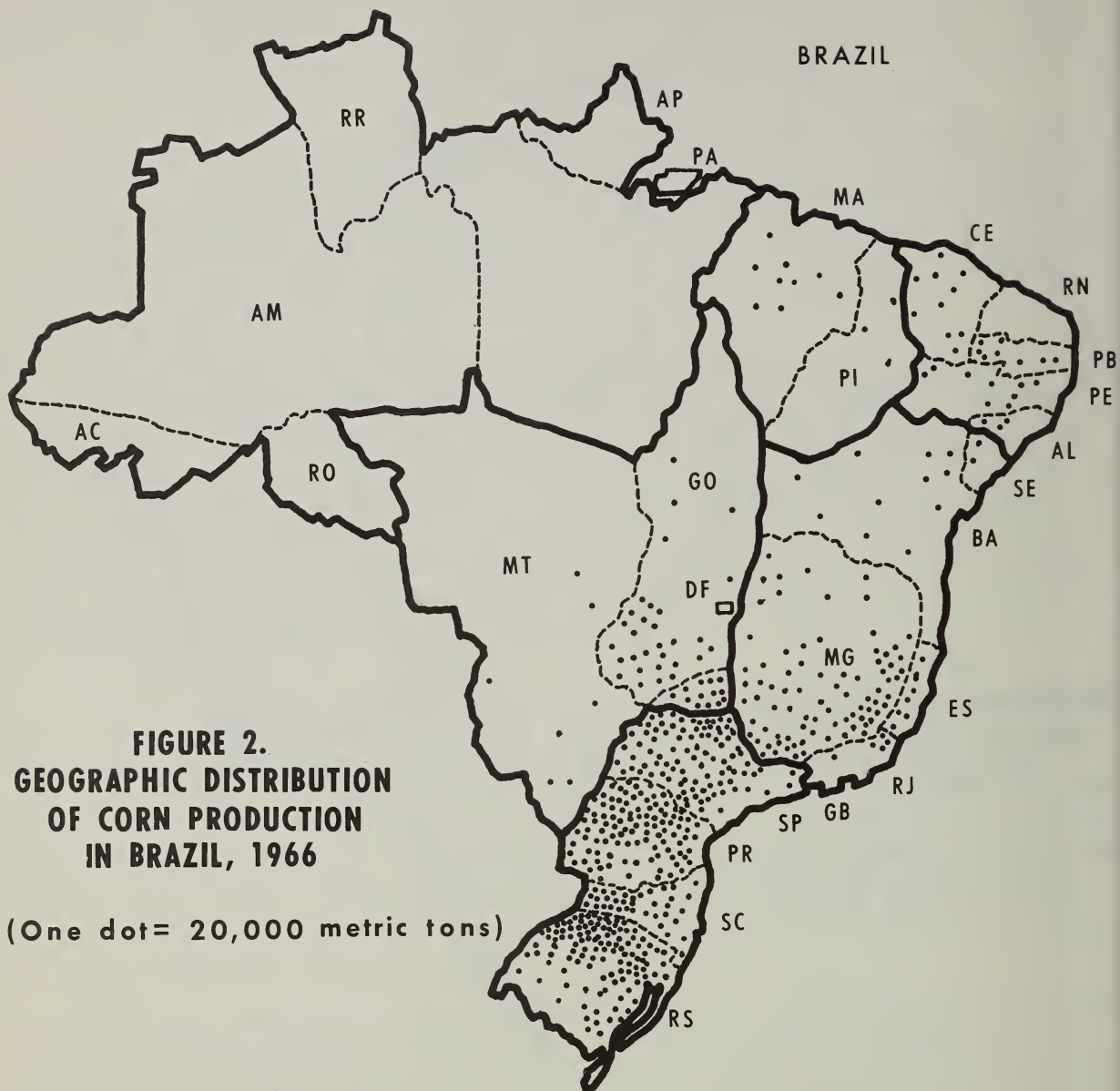
Since the 1952-54 period, the Central West Region has increased its share of national rice and corn production, while the East has failed to maintain its position, especially with respect to corn. In absolute terms, however,

^{1/} Tables begin on page 53.



FIGURE 1.
GEOGRAPHIC DISTRIBUTION
OF RICE PRODUCTION
IN BRAZIL, 1966

(One dot= 20,000 metric
tons, rough basis)





even the East has increased its area and production of both rice and corn (tables 2 and 3). Reported harvests of the two cereals were at record levels in 1965, but the 1966 harvests for each regional unit were also larger than the 1952-54 average, frequently by ratios of 2 or 3 to 1.

Regional Variations in Yields

Regional variations in average yields are outstanding for rice (table 2) and notable also for corn (table 3). Most of the rice of Rio Grande do Sul and Santa Catarina is irrigated and produced under other relatively intensive practices, with the result that yields average close to 3 metric tons per hectare. Upland rice is produced in most of the rest of the country, with average yields in the various regions seldom exceeding half the level of the two Southern States. Corn yields in the North, Northeast, and East are considerably below the levels reached in the more important commercial production areas.

In examining yield relations, it is important to recognize that associated cropping (interplanting of two or more crops) is common throughout much of Brazil. Corn, dry beans, mandioca, and various other crops are very commonly grown under such conditions. In some cases, two or more crops are planted in an alternating pattern at the same time; in other cases, a second crop is interplanted after the first crop has partly grown. When two or three crops occupy a given tract of land concurrently, it is scarcely to be expected that yields of each crop would equal those of a crop occupying the land alone. Various approaches could be used to prorate the land use among the various crops, but no such approach would be fully satisfactory.

For a number of years, the Ministry of Agriculture's Production Statistics Service (SEP) collected separate data on the area and output of crops grown singly and in association, although the data were usually combined before publication of the annual statistics. The SEP archives show, for example, that 72 percent of the bean area and 60 percent of the corn area in Paraná in 1965 were interplanted (table 4). Beans and corn represent a favorite combination throughout the country, a climbing type of bean being allowed to use the corn plant for support. The area of interplanted corn in a given State or region, however, is usually much larger than the interplanted area of beans.

THE COMMERCIAL PRODUCTION AREAS OF THE SEVEN REGIONS

In Region I, most commercial rice production is irrigated and takes place at elevations of less than 200 meters, whereas corn production is found at higher elevations, especially in the northern part of the region. Accordingly, it will be possible to discuss separately the two distinct production areas identified in figure 3.

A different situation prevails in Region II, where there is a rather broad distribution of production of both corn and rice. In the south-central part, however, corn is much more important than rice, so the total corn production area is somewhat more extensive than the rice area. The larger area will be taken as the basis for the discussion to follow, but it should be understood that part of this area has only a limited amount of rice production.

Much the same situation prevails in Region III, where production of corn and rice is intermingled throughout the southeastern part, but with less emphasis on corn in the portion of this area contributed by Mato Grosso. Again, the discussion will be in terms of the larger area.

Only the southern portion of Region IV has a sizable volume of corn production, and only a few municípios near the southeastern border can be considered commercial producers of rice. Accordingly, the commercial area identified in figure 3 will be treated as important primarily for its corn production. In contrast, the commercial production area of Region VI is primarily devoted to growing rice.

Region V is a continuous importer of rice and a frequent importer of corn, with no concentrated center of production for either crop. Likewise, Region VII, which includes 42 percent of Brazil's total land area but is only sparsely populated, has no sizable portions that can presently be identified as commercial production areas for either corn or rice.

The Rice Area of Region I

Brazil's most intensive area of rice production extends from the southern tip of Santa Catarina and the coastal zone of Rio Grande do Sul to the Uruguay River along the western border, including the great central depression of the latter State. The area identified in figure 3 comprises seven of the IBGE physiographic zones, which accounted for 85 percent of total 1966 rice production in Region I and for about 20 percent of national production. ^{2/}

Rice output in Rio Grande do Sul has shown a rather steady upward trend for more than 40 years, partly as a result of increased plantings and yields. Development of the industry has received strong support from the State's rice institute (IRGA), which provides assistance to growers, participates in marketing the crop, and publishes comprehensive statistics about rice plantings, output, production practices and costs, and marketings.

Much of IRGA's information about rice production is based on an annual survey of producers throughout the central and southern part of Rio Grande do Sul. Data concerning the 1964/65 crop were obtained in a total of 71 municípios, including a few outside the State's rice area identified in figure 3.

Size of Unit: According to the IRGA data, 90 percent of the State's rice output was produced in "plantings" (lavouras) of more than 9 hectares in size in the 71 municípios (21, p. 7 ff.). ^{3/} Four percent was produced in units of 9 hectares or less in the same area, leaving only 6 percent for the municípios in the northern part of the State not covered in the IRGA survey. No precise definition is reported for the unit of enumeration (lavoura), but the number of smaller plantings, averaging 5 hectares each, increased from an average of 3,400 in the 1950-54 period to 4,000 in 1964/65, while those of 9 hectares or

^{2/} Institute of Geography and Statistics (IBGE) physiographic zone classification is used for a variety of purposes.

^{3/} Underscored numbers in parentheses refer to items in the Literature Cited at end of report.

more almost doubled in number (table 5). Although the total number of plantings in the latter group rose from 2,900 to 5,500 over the same period, their average size changed only from 66 to 70 hectares.

The larger units are rather widely scattered throughout the commercial production area; 57 of the 71 municípios had at least one unit of more than 100 hectares, and the 26 units of more than 500 hectares were distributed among 12 different municípios. However, the six southeastern municípios (from Pelotas and Rio Grande southward) included 17 of the 26 largest units, plus 75 of the 183 units in the 251- to 500-hectare class. In contrast, these six municípios included only 52 units of 9 hectares or less, and relatively few small units are found across the remainder of the southern part of the State.

Irrigation: All of the rice grown in units of more than 9 hectares was irrigated. Water was raised mechanically for 71 percent of the area, flowed naturally to 23 percent, and was provided by a combination of the two processes for the remainder. Water comes from a variety of sources, including 35 rivers or streams and nine lakes, each of which served from 1,000 to 20,000 hectares of the 1964/65 rice crop. Altogether, 43 percent of the crop was watered from rivers and streams; 23 percent from lakes, including two large coastal lagoons (the Lagoa Mirim and Lagoa dos Patos); and 32 percent from artificial ponds (açudes).

Some of the irrigation water is raised as much as 50 feet, but two-thirds of the 3,578 pumping stations have a lift of 3 to 9 meters (approximately 10 to 30 feet). More than 5,000 pumps ranging from 10 to 80 centimeters (4 to 32 inches) in diameter are used, about 40 percent falling in the 20- to 25- centimeter (8 to 10 inches) class, a third from 30 to 50 centimeters (12 to 20 inches) in diameter, and 66, or 1.3 percent, larger than 50 centimeters.

Tenure: Given the large scale of water pumping and supply operations, it is not surprising that many growers make rental payments for water rights as well as for land. Altogether, nearly 4,000 of the 5,000 growers with more than 9 hectares of rice paid rent for land, water, or both. Nearly 90 percent of these growers worked on a percentage basis, but the remainder, who paid a fixed rent, accounted for around a third of the area involved. The number paying for water only was slightly larger than the number renting both land and water rights; only a small percentage rented only land.

Rental payments reported by those paying fixed sums appear to be highly variable, but available data and the charges used by IRGA in estimating production costs suggest that a typical level would be equivalent to the farm value of 300 to 400 kilos of paddy rice per hectare.

Diversification: Production of irrigated rice in Region I is usually associated with a considerable amount of livestock production. After land is used for several rice crops, it is converted to pasture. The rice straw and stubble also provide forage for the cattle. A considerable amount of milk is produced in the vicinity of Pôrto Alegre, but most of the cattle elsewhere are kept primarily for beef production. The southern part of Rio Grande do Sul also produces a considerable amount of wool, but the sheep enterprise tends to be located outside the principal areas of rice production.

In general, the livestock enterprise is the responsibility of the landowner, who may be quite willing to transfer responsibility for the rice crop to a share or cash renter who will contract for land on a field-by-field basis. The renters, who account for a large share of all rice production, are likely to specialize in the single crop, although their activities represent part of a diversified production system.

Other crops grown in the rice area of Region I are of relatively minor significance, compared with the production of rice and livestock. In the immediate vicinity of Pelotas, there is considerable commercial production of potatoes, and São José do Norte has the largest production of onions of any município in Brazil. Elsewhere, there is only scattered production of corn, wheat, other cereals, beans, and miscellaneous other crops.

Power and Machinery: The IRGA survey shows a relatively high degree of mechanization associated with the 5,500 units producing more than 9 hectares of rice. A partial list of the equipment reported on these units is as follows:

8,810 tractors (average of 40 horsepower)	1,775 mechanical seeders
3,638 tractor-drawn disc plows	2,761 manual seeders
2,330 tractor-drawn moldboard plows	11,617 carts and wagons
21,130 animal-drawn plows	3,700 autos, jeeps, pickups, and trucks
3,774 tractor-drawn disc harrows	3,207 threshing machines
7,530 animal-drawn disc harrows	762 combines
9,090 tooth-type harrows	764 driers

In addition, there were 86,271 work oxen and 12,366 work horses. The number of work animals and animal-drawn implements indicates that cultural practices are not yet completely mechanized but there has been a decided trend in that direction. Between 1950-54 and 1964/65, for example, the number of tractors per 100 plantings rose from 69 to 160.

Use of Fertilizer: In 1950-54, fertilizer was applied to 47 percent of the rice area in plantings of more than 9 hectares. By 1964/65, the proportion treated was only 55 percent, and the average application of 268 kilos per hectare was slightly lower than in 1950-54. However, the nutrient content of the fertilizer had probably increased in the meantime.

Varieties: Four varieties accounted for more than 90 percent of the 408,000 hectares grown in large and small plantings of the 71 municípios in 1964/65. "Agulha," a long-grain rice, was planted on 120,500 hectares. "Japonês" and "Calouro," both short-grain types, were planted on 116,000 hectares and 43,000 hectares, respectively. "Blue-Rose 388," a medium-grain type, was planted on 86,000 hectares.

Cost Structure: IRGA makes annual advance estimates of rice production costs per hectare, which provide a useful view of the general cost structure. Since the estimated structure has varied appreciably over recent years, comparative data for the individual crop years from 1961/62 through 1965/66 are presented in table 6. Some of the apparent variation may result from alternative ways of classifying expense elements, as well as from the general tendency toward more mechanization.

Marketing: According to a study recently made for CIBRAZEM (the Brazilian Warehousing Company), cooperatives market some 40 to 45 percent of the rice grown in an area corresponding approximately to the rice area of Region I (40, pp. 1-19). A large share of the remainder is sold directly to rice millers, who also receive some rice through country buyers. After milling, most of the rice from this area moves through Pôrto Alegre, from where it moves into international trade or is shipped for consumption in such Brazilian cities as São Paulo and Rio de Janeiro. In Pôrto Alegre, large-scale retailers and consignment agents (representantes) are handling a growing share of the rice trade, thus displacing the traditional wholesaler. Cooperatives and exporters are also present in the Pôrto Alegre market.

Total tonnage of storage capacity in the State of Rio Grande do Sul in 1964 was more than twice the tonnage of the 1964/65 rice crop (table 7). Much of the total capacity, of course, is used for wheat, other cereals, and various other products. Since wheat is harvested in the period from November to January, while the rice harvest extends from March through May, there is some opportunity for successive use of a given storage area for these two crops. The corn and soybean harvests tend to be a little later than the rice harvest.

Although the total amount of storage space is considerable, it should be noted in table 7 that nearly 60 percent is in private facilities of various business concerns. This is not generally available to producers who may wish to hold their crops for marketing after the low-price period of the harvest season. Moreover, part of the total capacity is more advantageously located for the storage of wheat and other products rather than rice.

In the 1950's, 10 or 15 percent of the rice crop was transported from the producing município by water, and an even smaller proportion by the somewhat precarious railroad system. By 1964/65, these two methods of transport had largely been abandoned, and practically all the rice was moved from the production areas by truck. The interior of Rio Grande do Sul, however, is served by only limited stretches of paved roads. Flows of products and inputs are often subject to considerable delay and added expense, especially during seasons of heavy rainfall. On the other hand, when agricultural limestone moves 100 to 150 miles by rail, the freight charges alone are likely to range between U.S. \$2.50 and U.S. \$3.50 per metric ton. Internal transportation is thus one of the significant impediments to expanded and more economical production.

Coastal shipping is used to transport a large share of the rice which leaves Rio Grande do Sul for São Paulo, Rio de Janeiro, and other Brazilian cities. The cost of such shipping and the associated problems of handling through the various ports have tended to encourage use of truck transport even for these rather long hauls. Other problems of communication also add to the difficulties of commerce--in 1966, when plans were being made for establishing TELEX connections with the rest of the country, the State of Rio Grande do Sul had only two telephone channels for calls to Rio de Janeiro and one to Brasília (33).

The Corn Area of Region I

Although corn production extends throughout practically all of Region I, the bulk of commercial output is north of the rice area, and especially in northwestern Rio Grande do Sul and western Santa Catarina (figure 3). According to the national atlas, this area can be characterized as a series of undulating plains at elevations between 200 and 800 meters in a subtropical climate with well-distributed rainfall (15).

Much of the production takes place at a distance of 200 to 400 kilometers from Pôrto Alegre and other major centers for consumption or transshipment. Given the almost complete lack of hard surface roads in the area, together with the precarious nature of rail service, there has been little tendency for corn to move into export channels or to other regions of the country. Instead, a large share has been fed locally to swine, and pork packing has become important in such municípios as Santa Rosa, centrally located in the physiographic zone known as the Alto Uruguai.

The general decline in demand for lard has been felt throughout the corn area over recent years, and has been only partially offset by efforts to introduce "meat-type" swine. However, soybean culture was successfully introduced some years ago, and the area now accounts for a large share of the country's total soybean production. The combination of corn, hogs, and soybeans suggests a basis for comparing the area with the Corn Belt of the United States, but marketing opportunities are much more limited and production is considerably less mechanized.

Diversification: Although the combination of corn, swine, and soybeans predominates in the Alto Uruguai and generally in the western portion of the commercial corn area, there is considerably more diversification in the area as a whole. The bulk of Brazil's wheat production also takes place in this area, and such intensive crops as tobacco and wine grapes are found in the eastern part. Dry beans are produced in considerable quantity, and a wide variety of other crops are intermingled. The cattle enterprise is represented throughout the area, and there is an appreciable amount of milk production in the eastern part. Santa Catarina now has a poultry-dressing plant which ships frying chickens to Rio de Janeiro

Farm Size and Organization: In the portion of this area belonging to the State of Rio Grande do Sul, a large share of the land was distributed in 25-hectare units under State and Federal colonization programs during the last half of the 19th century (19, p. 9). Immigrants from Germany, Italy, and other parts of Europe were numerous among the colonists. Over the years, there has been a considerable degree of subdivision of the properties among family heirs, especially in the eastern municípios, where units of 5 hectares or less are now by no means uncommon.

The concept of a farm unit operated directly by its resident owner, mainly with his own labor and that of his family, is more relevant in the commercial corn area of Region I than in many other parts of Brazil. According to data from the 1960 Census of Agriculture, hired managers were responsible for directing only 1 percent of all farms in the 12 physiographic zones comprising

the commercial corn area of Region I, while renters and occupants each accounted for 9 percent. Thus, fully 80 percent of the farms were under the direct operating responsibility of their owners. Also, less than 1 percent of all workers 14 years or more of age were sharecroppers, whereas 90 percent were farm operators or unpaid members of their families. It seems doubtful, moreover, that many families in this area own more than one property.

Under these conditions, data from the 1960 census can be presumed to give a relatively meaningful picture of the size of the farm operating unit--a presumption of doubtful validity for many other parts of the country (49). These data show that 62 percent of the units in the 12 physiographic zones were 10 to 50 hectares in size, while 27 percent were less than 10 hectares and 9 percent were 50 to 200 hectares. Only 2 percent were 200 hectares or more.

A quarter of all farmland in this area was used for crops at the time of the 1960 census--a proportion more than double that for the country as a whole. Land planted to corn in 1966 was equivalent to 12 percent of all land in farms in 1960, or about half the total used for crops. Wheat, soybeans, mandioca, and dry beans accounted for a combined total of about 10 percent of the land in farms (28, pp. 83-93). Nearly half the area not used for crops in 1960 was classified as natural pasture. About 12 percent of the total land in farms was idle, and most of the remainder was wooded.

In the two States of Region I, a total of 208,000 respondents to the 1960 census reported that corn production was their predominant activity. The farms of the 148,000 respondents in Rio Grande do Sul averaged 24 hectares in size, while those of the 60,000 in Santa Catarina averaged 31 hectares. If these farms were mostly in the commercial corn area, they would have represented half or more of all farms in the 12 physiographic zones.

Production Practices: Use of lime and commercial fertilizer in the area is still extremely limited, although highly favorable crop responses to these materials have been obtained in a number of instances. Where such inputs have been available, the small volumes distributed and the high costs of transportation have contributed to high prices and limited interest on the part of producers.

In 1966, a special effort to increase the amount of credit available for agricultural production was made in the Município of Ibirubá. The pilot project resulted in loans to 623 borrowers, of whom 279 had made no application for credit within the previous 3 years. A subsequent study found clear evidence of a general tendency to use more fertilizer and adopt improved production practices on farms where credit was made available (43). The project was initiated too late in the season to have much effect on corn production practices, but it indicated the receptivity of the community to new opportunities for change.

Farm size and organization in Ibirubá appear to be very similar to the pattern already described for the larger area in which it is located. The average-size farm was 32 hectares, and the principal crops were corn, soybeans, wheat, and mandioca. The sum of the areas planted to these four crops (including some duplication because of successive or interplanted crops) was equal to 60 to 90 percent of total farmland in the four intermediate-size classes of farms, which ranged from 10 to 100 hectares. One-sixth to one-third of the

farms in these classes had tractors, as well as mechanical planting and harvesting equipment.

In the Município of Santa Rosa, interest sparked by a soil-testing program resulted in community efforts to make agricultural limestone more readily and economically available and to encourage its use by farmers. As a result, some 400 farmers agreed to improve 10 hectares of land each by applying 6 metric tons of limestone per hectare. An immediate response by a local farmers' association was to order 6,000 metric tons of lime, after a mere 30 metric tons had remained on inventory during the previous years (3).

Cost Structure: In the commercial corn area in general, inputs of labor and power vary widely according to the techniques followed and the conditions under which they are applied. Tractors may be used in the phase of soil preparation, and occasionally thereafter, but horses or other work animals are more commonly used for planting and cultivating. Corn is commonly picked by hand, frequently several weeks after the stalks have been broken above the ear to facilitate drying. Under a system combining the use of tractors for soil preparation, work animals for cultivation, and manual labor for harvesting, typical inputs per hectare for a yield of 2,200 kilos have been estimated as follows (26, pp. 15-17):

Manual labor:		Use of equipment:	
Land preparation	22 hours	Tractor (land preparation)	6 hours
Planting	8 hours	Plow	4 hours
Cultural operations	52 hours	Harrow	4 hours
Harvest	55 hours	Planter	4 hours
Total	137 hours	Cultivator	9 hours
		Cart	6 hours
		Corn sheller	2 hours
Animal work:		Seed	16 kilos
Planting	4 hours	Ant killer	1 kilo
Cultural operations	9 hours	Sacking	37 sacks
Harvest	6 hours		
Total	16 hours		

The cost of these items, at the dollar equivalent of prices prevailing for the 1965/66 crop year, was U.S. \$23.60 per metric ton (about 60 cents per bushel).

Marketing: Since a large share of the corn in the area is fed to swine, any corn marketing which takes place is largely local. Storage facilities in Rio Grande do Sul have already been discussed in relation to the rice area. Additional storage exists in Santa Catarina, but in 1964 it was only equivalent to about 10 percent of that available in Rio Grande do Sul (table 7).

The Corn and Rice Area of Region II

Production of corn is broadly distributed throughout most of Paraná and São Paulo, except within a band extending 50 to 100 kilometers inland from the coast. Rice production is found throughout much of the corn area, but tends to be somewhat more concentrated in the northern and western parts of the respective States (figures 1 and 2). The Paraíba Valley of northern São Paulo

is also noted for its rice production, but this does not represent a large percentage of the State total.

The easternmost portion of Region II includes a coastal plain and a chain of mountains forming a divide which approximately parallels the coast. It also includes the two capital cities of Curitiba and São Paulo, plus the ports of Santos and Paranaguá. The remainder of the region slopes generally westward toward the Paraná River and is dissected by several of the latter's major tributaries, including the Tietê, the Paranapanema, the Ivaí, and the Iguaçu. Another tributary, the Rio Grande, forms the boundary between the State of São Paulo and the Triângulo portion of Minas Gerais. Elevations of the western slopes range between 500 and 1,200 meters, while the broad valleys of the Paraná and its tributaries fall within the 200- to 500-meter range.

Among the important soils of western Paraná and São Paulo are various latosols of red to dark yellow color, as well as the famous terra roxa (dusky red land) which is noted because of its adaptability for producing coffee and a wide variety of other crops.

Diversification: Sugarcane, cotton, soybeans, and peanuts are among the many competitors of corn and rice in selected zones of the region. Grasslands in the river valleys are extensively used for winter maintenance and fattening of cattle enroute from Mato Grosso, Goiás, and Minas Gerais to consuming centers along the coast. In many respects, this can be considered the agricultural center of the country, with a wide variety of production alternatives and relatively intensive agriculture.

During the long series of rises and occasional declines which have marked the evolution of coffee production in Brazil, Region II has come to an increasingly dominant position. This dominance, however, came after a rather late start. Coffee planting in Brazil is said to have originated in the State of Pará as early as 1727, but production remained on a small scale, mainly for domestic consumption, until about 1815 (47, p. 8 ff.). Fifteen years later, it had jumped to the leading position among Brazil's exports. Until after the middle of the century, commercial production was strongly concentrated in the State of Rio de Janeiro, especially in the highlands bordering the middle Paraíba Valley (44, p. 4). By 1854, the upper end of the valley in the neighboring State of São Paulo produced some 10,800 metric tons. From then on, a wave of expansion carried the center of production westward across the State and southwestward into northern and western Paraná. Concurrently, there was a gradual spread to the east and north into Espírito Santo and Minas Gerais, followed by a decline, especially in the latter State.

From 1900 through 1940, São Paulo alone accounted rather consistently for 60 to 70 percent of the country's total coffee production. Thereafter, the State's share began to decline, although its peak production was not attained until 1959. At that time, however, Paraná had overtaken São Paulo and was producing some 40 percent of the national harvest, after two decades of very rapid expansion. During the last decade, the two States combined have commonly produced about three-fourths of total national production, with the larger share coming from Paraná each year (14).

The area occupied by coffee trees in São Paulo declined by some 600,000 hectares between the peak year of 1959 and 1966. A decline of 300,000 hectares was registered for Paraná between its 1962 peak and 1966. In part, these declines no doubt reflect the results of the diversification program initiated by the national coffee institute in 1962 through GERCA (Executive Group for Rationalizing Coffee). This diversification program, to be sure, has not yet brought all the change originally sought; the national program called for diverting a total of 1,210,000 hectares in the first year alone, of which 300,000 were to go to corn (13).

In São Paulo, however, the relative importance of coffee in the total value of the State's agricultural production fell from 26 percent in 1959 to 8 percent in 1966 (7, p. 16). Paraná's agriculture is also gradually becoming more diversified.

Farm Size and Organization: The land tenure situation in Region II is considerably more complex than in the commercial corn area of Region I. Farms operated directly by the owner and members of his family are numerous, but many other tenure situations prevail. On the large coffee fazendas of São Paulo, much of the work has been traditionally performed by *parceiros* (sharecroppers) and *colonos* (workers under a fixed price contract for the care of a given area of coffee trees). Neither the typical *parceiro* nor the typical *colono* can be considered an independent producer, but many borderline cases are likely to be found under such conditions. Ownership of two or more farm properties by a single individual, partnership, or corporation is also prevalent; data for two municípios in São Paulo show that the number of owners was only about 80 percent of the number of properties (5, p. 103).

Nearly 40 percent of the farm units enumerated in the 1960 census for São Paulo were wholly or partly rented, and the same was true for about 35 percent of the units in Paraná. More farm operators paid in product rather than in cash, but both types of renting were common. More than 12 percent of the farm operators in Paraná were *ocupantes* (squatters), and about 5 percent of the census farm units in the region were under the responsibility of an *administrador* (farm manager or caretaker).

Under such diverse tenure conditions, census data on farm size are not as meaningful as under a situation where family-type farms predominate. Farm business units may be larger than the *estabelecimentos agropecuários* (agricultural establishments) enumerated by the census, to the extent that multiple ownerships or partially owned units prevail, but some production decisions may originate in the narrower context of the sharecropper or *colono* unit.

In Paraná, much land was settled under various private and public colonization schemes, which resulted in a size distribution of census units corresponding very closely to that of the corn area of Region I. This is especially true in the north and west physiographic zones, which account for two-thirds or more of the corn and rice, plus nearly all of the coffee, cotton, and soybeans grown in the State. In these two zones, the average size of the 1960 census units was 35 hectares; 53 percent were 10 to 50 hectares, 36 percent were less than 10 hectares, and 9 percent were 50 to 200 hectares, leaving only 2 percent that were 200 hectares or more. On the average, perennial crops

occupied 8.6 hectares and temporary crops 5.7 hectares, but the 1966 SEP data for corn and rice plantings alone give a larger total than the area identified as being used for all temporary crops in 1960. This reflects expansion during the intervening 6 years, and also the fact that corn and other crops are commonly interplanted with coffee, while beans are interplanted with corn.

In São Paulo, the five physiographic zones with the largest combined acreage of corn and rice in 1966 were Barretos, Rio Preto, Campos Gerais, Assis, and Ribeirão Preto. The average size of the census units in these zones in 1960 was 82 hectares, or more than twice as large as in northern and western Paraná. Again, about 37 percent of the units were less than 10 hectares, but only 38 percent fell within the 10- to 50-hectare range, while 17 percent were 50 to 200 hectares, and 7 percent were 200 hectares or more, including 286 units of more than 2,000 hectares. Nearly a quarter of the total farmland in these five zones was used for crops, with an average per estabelecimento of 5.5 hectares allocated to permanent crops and 13.5 to temporary crops. (Note that sugarcane, which is important in some of these zones, is counted as a temporary crop.)

In the two States combined, corn production was designated as the major enterprise of 162,000 census respondents in 1960. Of these, 112,000 were from Paraná--presumably mostly from the northern and western physiographic zones, where they would then have represented half or more of all producers. Those reporting rice production as their major activity totaled 52,000, mostly from the State of São Paulo. In each case, the average size of estabelecimento was around 30 to 40 hectares.

Ettori and Falcão have estimated that corn plantings in São Paulo typically range from 7 to 50 hectares in size, with extremes of fractions ranging to 700 hectares. It was reported that of the 1964/65 crop 61 percent was produced by landowners, 22 percent by sharecroppers, 13 percent by renters, and 4 percent by colonos and others whose status was primarily that of a hired worker (9, pp. 12-13).

Altogether, one may conclude that corn represents an important crop on units of small to medium size in areas where there is a wide choice among alternative crop and livestock enterprises. Much the same can be said for rice, although the units producing rice are not necessarily the same ones, or even in the same municípios, as the ones producing corn.

Production Practices: Ettori and Falcão estimated that one-third of the corn area in São Paulo is grown under "rational" or improved practices, whereas the remainder is under more traditional practices. Nine percent of the total area, they concluded, was interplanted with coffee, beans, rice, or other crops (9, note 1 on p. 2; also p. 12).

In general, agricultural practices in São Paulo are relatively intensive, compared with much of the rest of the country. This applies to the use of improved seed, including hybrid seed corn, the use of fertilizer and pesticides, and the extent of mechanization. In 1964, for example, total plant nutrient applications in the State were estimated to represent more than half the national total, and expenditures for fertilizers now approach the same percentage

of gross agricultural income as in the entire United States. ^{4/} Only a small proportion of the fertilizer is applied directly on corn or rice, but some benefits may be realized by these grains when rotated or interplanted with such heavily fertilized crops as coffee, cotton, and sugarcane.

Although corn yields in São Paulo have averaged around 1,500 kilos per hectare, with a high of 1,877 kilos in 1966, Ettori and Falcão pointed to results of a competition sponsored by the State Agricultural Secretariat as evidence that yields of 3,000 kilos or more are readily attainable. They mention the inadequacy of lime applications and give a list of 17 obstacles to higher yields (9, p. 11).

Cost Structure: The same authors provide estimates of the physical inputs used in corn production on rather small properties using animal power and on larger properties with tractors in a sample area of São Paulo (tables 8 and 9). The cruzeiro value (NCr\$) of these inputs in 1964/65, plus a 15-percent allowance for interest on circulating capital and for overhead, was equivalent to about US\$20 to 25 per metric ton. (No allowance for land rent is included in this figure.)

The Divisão de Economia Rural (now the Instituto de Economia Rural) produced an entire series of similar estimates of physical inputs and direct expenses for various crops. Their data on inputs per hectare for rice are as follows (22, table 3):

Manual labor:		Use of equipment:	
Plowing (twice)	5 days	Plow	5 days
Harrowing (twice)	2 days	Harrow	2 days
Planting and fertilizing	4 days	Cultivator	5 days
Cultural operations	21 days	Planter, fertilizer distributor	4 days
Harvest (including threshing)	21 days	Cart	1 day
Total	53 days	Seed	33 kilos
		Superphosphate	200 kilos
Animal work:		Ammonium sulfate or equivalent	100 kilos
Plowing and harrowing	13 days	Muriate of potash	50 kilos
Planting and fertilizing	5 days	Aldrin (5 percent)	1 kilo
Cultural operations	5 days	Sacking and twine	31 sacks
Harvest	3 days		
Total	26 days		

These inputs presupposed a yield of 1,860 kilos per hectare. The cost of these inputs in 1965/66, plus the 15-percent allowance, was equivalent to US\$75 to 80 per metric ton.

Marketing: In southwestern Paraná, as in the adjoining corn area of Region I, much of the corn crop is fed locally to swine. This enterprise is of such importance that a large new packing plant was opened about 3 years ago in Toledo by a company which already was operating a plant in Concordia, Santa

^{4/} Data assembled by R. B. Cate, Jr., visiting professor, International Soils Testing Project, North Carolina State University.

Catarina. Swine are also trucked from western Paraná for slaughter in the eastern part of the State and in São Paulo.

Swine have often been turned loose in the corn fields, especially on the larger holdings, but immigrants from the south have tended to practice pen feeding, partly because their small holdings were not always fenced. Thus, a considerable share of the corn is picked, and may be sold from one farm to another, or used locally for feed mixing. A small amount is shipped out of the area on the Paraná River, being forwarded through the port of Foz do Iguaçu. Since most of the swine are the lard type rather than meat type, the swine enterprise has not been highly profitable recently, with the result that more corn may have been marketed and shipped out of the zone than would otherwise have been the case.

The remainder of the area represents the principal source of corn for industrial processors and feed mixers centered around the city of São Paulo and for export, mainly through the ports of Santos in São Paulo and Paranaguá in Paraná.

In 1967, corn exports through the port of Paranaguá and the smaller nearby port of Antonina totaled about 250,000 metric tons, distributed over the period from June through October. About three-quarters of this tonnage arrived at the ports by truck and the remainder by rail (25). Total corn shipments through the Paraná ports during the first 8 months of 1968 were reported at 337,000 metric tons, while Santos reported 383,000 metric tons for the same months. Preliminary estimates indicate that the country's total corn exports in 1968 were about 1.2 million metric tons.

Santos is now prepared to receive and load corn in bulk, but sacks have been used until recently for all shipments to the various ports. With the high price of new sacks and with the practices followed in opening them for loading, this has proven very costly. The need for more general adoption of bulk handling from farm to market is now generally recognized, but much remains to be done before it becomes a reality.

Corn for export has enjoyed a favorable situation with respect to trucking charges, since it provides an off-season activity for coffee truckers and also a return load for trucks hauling petroleum products and other materials to the interior. (In this area, gasoline tankers are commonly constructed with a flat top which can be loaded with sacks on the return trip.) It has been noted that competition brought truck rates as low as NCr\$0.90 per sack for the haul from Maringá to Paranaguá in 1967, compared with NCr\$1.24 established as the rail tariff (25).

At the time of a recent study in the State of São Paulo, it was found that corn producers were making about 20 percent of their sales to industrial users, 45 percent direct to wholesalers, and 35 percent to assemblers who sold to wholesalers. Of the 80 percent of the corn passing through wholesale channels, about 20 percent was going to exporters and around 40 percent was going to industry, including feed mixers and producers of corn oil, starch, and dozens of other corn derivatives. In the city of São Paulo, brokers and buyers' representatives were handling 30 percent of the trade; in the country,

itinerant operators of corn-shelling equipment, truckers, and exporters or their representatives are among those who take part in the assembly process (23, pp. 54-57).

On the balance, Region II is a deficit rice producer, but there is a considerable commercial flow from the western part toward São Paulo, which is not only a large consuming center but also a central market which forwards rice to other cities. Rice is received from practically all States of the south-central part of the country, including Rio Grande do Sul, Mato Grosso, Goiás, Minas Gerais, and even Rio de Janeiro. Preference is shown for the long-grain rice grown in such States as Goiás and Mato Grosso.

The São Paulo study already cited identified three classes of participants in the rice-marketing process: (a) the miller-wholesaler, (b) the wholesaler-intermediary, and (c) the retailer. There are more than 2,000 rice mills in the State of São Paulo alone, most of them with capacity for processing 2 to 12 metric tons of rough rice per 10-hour day. Fifty or more firms operate in the rice trade of the city of São Paulo; cooperatives account for only about 2 percent of this trade. The study showed that the State's rice producers tended to receive something over 70 percent of the retail price in years of small crops, but less than 60 percent in years of large crops (23, pp. 9-36).

The 1964 survey of Brazil's storage facilities showed a total capacity of more than 8.5 million metric tons in the States of São Paulo and Paraná (table 10). This was more than half of the total national capacity, estimated at 15.3 million metric tons. Bulk storage accounted for only about 10 percent of the combined total for São Paulo and Paraná. The two States had almost identical capacities under business and Federal ownership, but between 80 and 90 percent of the State, municipal, cooperative, and producer storage was in São Paulo. The São Paulo State storage company (CAGESP) is active, and is currently planning construction of relatively large silos in both Campinas and Santos, with a view to expediting ocean shipments. Capacity for 30,000 metric tons is being planned for each location, in the first stage, with layouts which could be expanded to 100,000 metric tons each at some later date.

The Corn and Rice Area of Region III

Region III is well removed from the densely populated band along the coast and is often considered the agricultural frontier. The part identified as the corn and rice area in figure 3 roughly corresponds to the Planalto Central (central high plain), which has recently been the object of considerable interest because of its agricultural development potential, enhanced by location of the new National Capital in the east-central part.

Colonization and the development of accompanying infrastructure in Region III are gradually radiating westward and northward from the southwestern border with São Paulo. The city of São Paulo represents a point of convergence for the principal highways and traffic flows from Region III, although additional routes toward Belo Horizonte and Belém have developed since Brasília became the National Capital.

A group commissioned by the U.S. Agency for International Development (USAID) to make an exploratory survey of the agricultural development potential of the Planalto Central found generally favorable environmental conditions with respect to climate, rainfall, groundwater supplies, topography, and soil structure. Rainfall commonly ranges between 1,500 and 2,000 millimeters (60 to 80 inches), mostly between October and April, with a long dry season during the remainder of the year. Elevations are mostly between 300 and 1,200 meters, with large areas where slopes present no handicap to mechanization. Natural fertility of the soils in large areas is extremely low, probably accounting for the savanna-type vegetation which has characterized some 80 percent of the area, and which is commonly known as campo cerrado (8, pp. 2-12).

The exploratory group identified limited areas of soils as having good natural fertility. These are closely related to the zones in the Triângulo of Minas Gerais and the nearby portion of southern Goiás where a large share of present corn and rice production takes place (figures 1 and 2). Production is also getting started in other zones, however, so sizable portions of central and southern Mato Grosso and central Goiás have been included as part of the commercial corn and rice area outlined in figure 3.

In Brazil's itinerant agriculture, rice is often preferred as a pioneer crop to be planted in the first stage after clearing the land. Later, corn is likely to enter the combination of crops. Together, the two crops account for a large share of all tillage in the region.

Farm Size and Organization: Land holdings in this area are considerably larger than in the three commercial areas discussed previously. In Mato Grosso and in some parts of Goiás, average size is strongly influenced by the presence of large ranches and undeveloped properties which often exceed 2,000 hectares and occasionally exceed 100,000 hectares. Even in more representative zones of the corn and rice area, the average size of the estabelecimentos enumerated in the 1960 census was around 250 to 500 hectares or more.

In the past, crops on such units were often grown by sharecroppers, but this practice seems to be diminishing with the coming of mechanization. Sharecroppers accounted for only 10 percent of all males working in census units in Goiás in 1960; the comparable figure for Mato Grosso was only 2 percent.

Where sharecroppers participate in the production process, they are frequently the ones who do the clearing and initial planting. In some cases, their principal role may be to help establish pastures for the landowner's cattle. On the other hand, when the landowner is interested in crop production as an end in itself, he may own or hire a tractor for plowing and harrowing, subsequently assigning tracts to sharecroppers who provide work animals for cultivating and manual labor for harvesting.

Migration continues to this area from Minas Gerais, Bahia, and the Northeast, as well as from São Paulo and the South. Some migrants come only for the crop season or harvest, with the expense of passage advanced by truckers or labor contractors. Many remain to work as salaried laborers, sharecroppers, or squatters. A number of publicly or privately sponsored colonies have also been established, frequently with less favorable results than expected.

Both Brazilian and foreign investors have been attracted by the generally low price of land per hectare in the area, and transactions involving large areas of land have been frequent, sometimes without an effective transfer of title to the would-be buyer. ^{5/} As has been the case in many frontier areas, systems for identifying land parcels and providing secure titles are not highly developed; in some sections of Goiás and Mato Grosso, the tenure situation approaches being chaotic. Thus, it is difficult to identify what lands are Federal, State, or private property.

When private property owners were required to declare their rural holdings to IBRA in 1966, the declarations in Mato Grosso accounted for only about half of the State's total area, and only about two-thirds of the land in Goiás was declared (18). There may have been some underreporting to reduce tax liabilities or for other reasons, but this would have been considered risky in terms of jeopardizing existing title claims. In any event, the total area declared to IBRA in the country as a whole was a third to a half larger than the total areas enumerated in the 1950 and 1960 censuses.

Under existing procedures for land titling, it is not easy for individual colonizers to settle in new areas without accepting serious risks with respect to security of tenure. Almost 20 percent of those responsible for the units enumerated in the 1960 census identified themselves as ocupantes or squatters, and many of those who identified themselves as property owners may have had less than certain title to their lands.

Rice growing was identified as the predominant activity on nearly half of all 1960 census units in Goiás and Mato Grosso, and corn production was the predominant activity on another 9 percent. If data were available separately for the commercial corn and rice area, they might show an even greater emphasis on these two crops. However, cotton, soybeans, sunflower, dry beans, pineapple, and even some coffee are grown in various parts of the area.

In the physiographic zone known as Meia Ponte in southern Goiás, half the units enumerated in the 1960 census reported between 5 and 50 hectares in crops, and nearly 10 percent reported a crop area of 50 to 500 hectares or more. This zone represents much of southern Goiás and the Triângulo of Minas Gerais, while the zone of Campo Grande accounts for much of the corn and rice area of southern Mato Grosso. In the Campo Grande zone, the census again found half the units with a crop area of 5 to 50 hectares, but less than 2 percent with more than 50 hectares.

Production Practices: Production practices differ only moderately from those of the upland areas already discussed. Here, as in many other parts of the country, rice production tends to be itinerant, moving to new areas cleared of woodland or brush every few years. Under such conditions, the axe, hoe, and sickle are the principal tools for manual laborers.

^{5/} According to the Brazil Herald, results of a congressional inquiry show that hundreds of Americans have fallen victims to dubious real estate dealers, some being Americans and some Brazilians (2). Some of the problems of obtaining clear titles to Brazilian land are discussed in a recent publication of the U.S. Department of Commerce (46).

In the Triângulo of Minas Gerais and the immediately adjoining zones of Goiás, tractors are frequently used for plowing and harrowing. Subsequent cultivation may be entirely by hand, or considerable work with a hoe may be used to supplement three or more cultivations with a one-horse, one-row cultivator.

Treatment of seed is a widespread practice in rice production. Use of fertilizer is less common, especially on corn. Almost daily patrolling is frequently necessary to locate and destroy ant colonies. Insecticides are occasionally used to control corn borer and other pests.

Yields of both corn and rice seem to compare favorably with those obtained under the somewhat more intensive cultural practices followed in São Paulo--perhaps, as is commonly argued, because the newly cleared lands have not been exhausted by long continued cultivation.

Cost Structure: The inputs given earlier for the corn area of Region I can be taken as representative of inputs in this area also. Naturally, wide variations are found within each region. Inputs for rice production at two levels of intensity appear in table 11. Expenses for these inputs in 1965/66 would have been equivalent to US\$45 to 75 per metric ton, depending principally on the assumed yield.

Marketing: Cities such as Uberlândia, Anápolis, Goiânia, and Capinópolis are major points for rice milling and marketing. Country buyers and truckers visit farms in areas remote from rice mills, as in central Goiás. Corn may be sold to truckers or itinerant operators of corn-shelling equipment who serve the area. Brasília is a growing market for rice as well as for many other products grown in the area, and new rail connections will favor shipment of rice to the Belo Horizonte market, whose rice prices have often been above those of São Paulo and Rio.

The Corn Area of Region IV

The State of Minas Gerais, as its name implies, has long been a center for various kinds of mining activity. The long continued search for gold by pioneer expeditions finally resulted, early in the 18th century, in an intense settlement around Ouro Preto, later to become colonial capital of the country. Although the lands of much of the surrounding area are hilly or mountainous and not particularly well adapted to agriculture, the gold miners had to eat, and a considerable amount of agriculture developed to serve the local needs.

Both mining and agriculture have become much more diversified and extensive throughout the southern half of Minas Gerais in the succeeding 250 years. Nevertheless, a great deal of the corn and rice production is still for local subsistence, and production techniques in some localities have not changed greatly from century to century. On the other hand, an important share of commercial production probably originates in scattered localities which have adopted some elements of modern technology, and where practices are very similar to those already described for corn production in Regions I, II, and III. This also applies to the small zones in the States of Rio de Janeiro and Espírito Santo which have been included in figure 3 as part of this commercial corn area.

According to SEP data, Minas Gerais has more swine than any other State. Although these data may overstate swine numbers to some extent, it is obvious that a large share of the State's corn crop is used for feeding swine and some poultry.

In general, this area has been diminishing its percentage contribution to national corn and rice output, while continuing to show a gradual increase in absolute production (tables 1 and 2). There has been some tendency for larger production increases in the central to north-central part of Minas Gerais, especially in the Paracatú zone, which extends southeastward from the Minas border with the Federal District and straddles nearly half the length of the new highway from Brasília to Belo Horizonte (39, p. 9 and maps 1 and 2).

The Rice Area of Region VI

São Luis, capital of the State of Maranhão, was founded in 1612, and the area surrounding it soon began to participate in the early sugar industry, which represented a major export activity at many points along the country's coastline. For generations afterward, however, the economy of Region VI tended to stagnate, and Piauí is still known as one of Brazil's poorest States.

Although the two States are commonly grouped with the Northeast Region, they really form a transition zone between the humid Amazon Basin and the remainder of the Northeast, including the "Drought Polygon." In Maranhão, at least, rainfall is generally ample and the relatively level terrain would present no obstacle to development of a mechanized agriculture. In practice, however, the agriculture of the area is largely of an itinerant and rudimentary nature, involving practically no use of animal or mechanical power, fertilizer, or other purchased inputs.

Farm Size and Organization: Since land is relatively abundant, and since rice milling or other commercial activity is often an important interest of large landowners, such individuals have to assure an adequate labor supply for exploiting the land's crop potential. This is often accomplished by making land, and sometimes credit, available to families who will cultivate the land. A dozen to several hundred such families may reside on a large landholding, receiving the right to clear and use certain plots for growing their rice and subsistence crops, as well as to gather the babaçú palm nuts growing in these or other specified parts of the property. Commonly, the landowner is entitled to receive a fixed quantity of product (e.g., 100 kilos of rice) for each hectare planted, but this *fôro* (land rent in fixed quantity of product) is often waived if the *morador* (literally, resident) agrees to sell his product through the landowner, or perhaps in return for work performed for the landlord (32, pp. 21 ff., especially pp. 61-77). Whether rent is paid in cash, in a specified quantity of product, in a share of product, in labor service, or simply by marketing products through the landlord becomes a matter of secondary importance, except when classifying the unit for such purposes as census enumerations.

The census has not enumerated *moradores* as such, but many of them were probably classified in the 1960 census as renters making payment in product or

as ocupantes (individuals occupying land without title or lease). In any event, the small-size unit reflects the pattern for typical families of the area. Of the 262,000 estabelecimentos enumerated in Maranhão, 230,000 were less than 10 hectares, and 80 percent showed rice production as their predominant activity. Only 35,000 were operated under the direct responsibility of the owner or a hired manager, the remainder being under either arrendatários (renters) or ocupantes (occupants).

Some 126,500 of the ocupantes, representing nearly half of all census units in the State, were using lands owned by a public entity. These squatters or other ocupantes of public lands represent not only a large share of all units less than 10 hectares in size but also an important share of the increase in small units between the 1950 and 1960 censuses (table 12). During this decade, the count of estabelecimentos less than 10 hectares increased from 75,000 to 230,000, while the count of ocupantes on lands of public entity increased from 50,000 to 126,500. This rapid growth could be attributed to more complete reporting, an actual increase in numbers, or, more probably, a combination of both. It also reflects some attempts to establish publicly sponsored colonies in the State, through efforts of SUDENE, the Northeast's regional development agency. Spontaneous colonization by migrants from the remainder of the Northeast also is developing (36, p. 78).

The increase in the number of ocupantes between 1950 and 1960 was accompanied by an even more drastic change in the count of renters. After falling from 12,000 in 1940 to 5,000 in 1950, the 1960 census count of arrendatários rose to 88,000. Of these, 40,000 paid cash rent and 48,000 paid rent in product, a distinction made for the first time in the 1960 census. The latter group, at least, corresponds to the typical moradores of the region.

In some respects, the moradores can certainly be considered independent agricultural producers, inasmuch as they have a considerable degree of freedom in deciding how much land to plant, what crops to grow (within the narrow range found to be economic in the area), when to plant, and what cultural practices to follow. The form of tenure would also suggest that they are producing for their own account and at their own risk, although the landowner may, in reality, share the risk if he loans money or cosigns notes to provide production credit. Kinship, whether real or symbolic (32, p. 26), and other sociological factors also tend to reduce the true independence of the moradores. Moreover, the tendency toward shifting cultivation means that their units have no really fixed boundaries. For this reason, incidentally, Nicholls and Paiva suggest that the size of unit reported in the census, both for arrendatários and for ocupantes, may reflect much less than the total area available to, and used by, a given family over a span of several years (23, p. 21).

Given these tenure and land use patterns, the introduction in the 1960 census of a distinction between tenants paying in cash and in product may have had a considerable effect upon the enumeration. There is, of course, only a fine line between an independent producer paying rent in product (arrendatários; pagamento em produtos) and a sharecropper (parceiro). The 1960 census sought to include among the arrendatários only such share tenants as were "autonomous" (parceiros autônomos). There seems to be no indication that the intention was different in 1950, when land operated under parceria (sharecropping) was not treated as a separate unit if it was subordinated to the general management

for the property as a whole. In the 1950 census report, it was explained that the term arrendatários was used to include those responsible for operating units under a lease or under parceria. However, there was no specific mention of parceiros among the various classes of persons who could be considered "responsible" for a farm unit (owners, co-owners, renters, occupants, etc.).

It is worth noting that the IBRA summary, based on declarations by property owners or their representatives, reported only 13,000 arrendatários, 40,000 parceiros, and 12,000 ocupantes on the 62,000 properties included in the tabulation. The total number of properties in the complete count is expected to rise to about 80,000, with a total area more than twice that enumerated in the 1960 census, but with a smaller number of renters. On the other hand, the census reported only 12,000 parceiros, compared with the IBRA count which is expected to rise to around 50,000 for the 80,000 properties. With respect to occupants, the IBRA count was much lower than the census count, for the obvious reason that few if any occupants of public lands were included in the IBRA registration of properties.

Production Practices: Since culture is entirely manual, subsistence crops such as corn and mandioca are often interplanted with rice. Newly cleared land is cut over, burned, and planted with no attempt to complete preparation of a seedbed. Planting of rice begins in January and is done in hills opened with a hoe. Short-grain varieties, such as "Come-Crú" are commonly grown, usually from seed saved by the producer. Apart from two cultivations with a hoe, the main treatment is to combat ant colonies. Harvesting and threshing are performed by hand, and the grain is dried in the sun. Labor inputs per hectare for a crop yielding 1,000 kilos have been estimated as follows (27, p. 16):

Land clearing and preparation	20 to 30 man-days
Planting	3 to 7 man-days
Cultural treatments	20 to 40 man-days
Harvest	15 to 30 man-days

Marketing: Marketing is practically always through the rice miller, who may also be the landowner. Short-grain characteristics of the rice and deficiencies of the milling operation limit the acceptability of the final product, both in foreign trade and in major cities of south-central Brazil. Coastal transport, moreover, has been extremely costly. However, as mentioned earlier, a considerable share of the Maranhão crop moves out of the State to supply such Northeastern cities as Fortaleza and Recife. Truck shipments are becoming more common, although there are only a few through highways, which are often in somewhat precarious condition.

SOME FACTORS AFFECTING PROSPECTS FOR PRODUCTION AND EXPORTS

Of the numerous factors affecting prospects for corn and rice output, only a few will be singled out for comment here. Even for these selected factors, the discussions can by no means be exhausted.

Demand and Prices

Although Brazil's corn and rice exports have been sizable in certain years, they have seldom exceeded about 5 percent of annual production. Direct human consumption domestically is the principal final use for both these products, although much of the corn is transformed into meat and other farm or industrial products before reaching the ultimate consumer. Even a very large percentage increase in exports would not change the predominance of the domestic market. Furthermore, except for wheat, dry codfish, deciduous fruits, barley and certain minor items, such as garlic, Brazil depends almost entirely upon local supplies of food and fiber. Total imports of farm products seldom exceed around 5 percent of annual consumption.

Market demand for food products consumed domestically is usually analyzed in terms of population growth and changes in consumption per capita. The latter, in turn, is influenced by changes in age distribution, employment of the population, tastes, relationships among prices of various products, and, above all, income per capita available for consumption expenditures. Factors affecting industrial and export demands usually require analysis in a somewhat different framework. Special food distribution programs sometimes represent an additional factor in the domestic market.

Brazil's total population has been growing at a rate of 3 to 3.5 percent annually. For the next 5 to 10 years, no great change in this rate is likely. The growth of gross domestic product per capita has been much more sporadic, but the average annual rate of growth between 1953 and 1966 was about 2.5 percent (10, p. 118). Consumer demand for food in general, and for most food products individually, is expected to rise at a somewhat slower rate--say between 1.5 and 2.0 percent annually, assuming an income elasticity of demand in the neighborhood of 0.7. The increases in population and per capita incomes would thus be contributing to growth of consumer demand for food at a rate of about 5 percent a year (very probably within the range of 4.5 to 5.5 percent).

The income coefficient of demand elasticity is a very convenient theoretical measure of demand changes associated with income changes, but there are various limitations in using coefficients of this type to estimate future changes in demand for individual products. Neither historical nor experimental techniques can adequately predict how human beings will behave under continually changing circumstances. However, both logic and empirical evidence suggest that the income elasticity of demand for rice may be lower than for all food, while the opposite may be true for corn, taking account of its derived demand in the production of processed food and livestock. 6/

The latter factor particularly makes it difficult to project realistic estimates of the demand for corn, partly because future adjustments in livestock production and marketing are uncertain. Until very recently, for example, chicken has been the kind of luxury item in urban consumption that it was in the United States in the 1920's. Only in the last year or two have consumers

6/ For rice, the income elasticity of demand may be as low as 0.21 in urban areas, according to estimates of the Getúlio Vargas Foundation (11, p. 47).

in São Paulo and Rio de Janeiro been able to buy attractively dressed and packaged fryers at prices per kilo competitive with those for good cuts of boneless beef and considerably below those for filet mignon. Such prices are still only available in a limited number of establishments in certain major cities. Similarly, consumers are beginning to feel the effects of a parallel revolution in egg production and marketing.

Pork cuts, in general, and ham, in particular, have also been represented only sparsely in established consumption patterns, perhaps principally because they have been expensive, except in restricted production areas.

As pork and poultry products become more readily available at reasonable prices, consumption should respond in a manner that can theoretically be estimated by a coefficient of demand elasticity with respect to price. But there may be a much greater delayed demand, based partly on gradual changes in consumption habits, the appeal of new forms and packaging of products, and the wider availability of products across the country and in various classes of marketing establishments. Such changes can materialize rather rapidly or very slowly, depending on behavior by producers, marketers, and consumers.

Brazil's capacity for industrial processing of corn has also been growing rapidly in recent years. A large share of the country's processing capacity is in the vicinity of São Paulo and Campinas, where the largest refiner is said to have present capacity for processing 200,000 metric tons or more of corn annually, and where one large plant is scheduled to double in size soon. No drastic change in growth rates seems particularly likely for the intermediate term, however.

Rice has no appreciable industrial market in Brazil and its significance for animal feeding is only in the limited use made of mill byproducts.

Brazil's corn and rice have entered the international market so erratically in the last two decades or more that the country still lacks recognition as a dependable supplier (table 13). The infrastructure for continuous trading is not fully developed, and some uncertainties about grading and trading conditions may exist in the minds of buyers. Also, Brazilian corn has sometimes sold at a considerable discount on European markets, compared with Argentine corn. Currently, Brazilian corn in European markets has tended to sell at prices between those of Argentine and U.S. corn. Rice exports have depended considerably upon special seasonal situations in the market for certain types and qualities--usually in grades containing a relatively high proportion of kernels broken during milling.

During each of the last 5 years, Brazil has exported both corn and rice, and steps are being taken to improve the country's potential for competing in international markets. Among other steps already taken, Decree 62,940 of July 2, 1968, strengthens guarantees for both foreign importers and local exporters that contracts will be fulfilled under specified conditions of price and quality. Perhaps even more important are the steps being taken to reduce friction in moving products through ports, as well as to improve these ports and the connecting highways. The new highway from Curitiba to Paranaguá,

financed in part by USAID through the Alliance for Progress, is an example. Also, major projects for port improvement are either planned or underway at both Paranaguá and Santos.

Recent planning and execution of basic price policies also reveal efforts to maintain economic conditions favorable to Brazilian export of corn and rice. By law, world prices must be considered in establishing support levels under minimum-price programs, and there appears to have been no serious attempt to set internal corn and rice prices above world price levels. Also, in some instances, the announcements of currency devaluations during the continuous inflation of recent years have been timed in a manner that facilitated exports of corn and rice, as well as of industrial products.

Minimum prices have become of major significance for producers only since 1965 or later, although minimum-price programs have been in effect for some 20 years. Until 1962, minimum prices were generally set below the lowest expected prices to avoid the need for purchases, except in extreme cases. Moreover, if the market did happen to fall, the program usually failed to prevent prices from going below the support level, owing to lack of financial resources and administrative organization.

By 1964, efforts to hold prices under ceilings had become more significant for producers than the program of minimum prices. Direct controls for this purpose were supplemented by export controls on various products and by exchange rates that were sometimes artificially high. Increasingly, the Government resorted to buying or confiscating foodstuffs and participating in the distribution process to avoid obvious food shortages or more serious consequences in the cities. SUNAB, the Federal authority for price and supply control, sometimes engaged in dramatic measures, such as the helicopter flights by officials seeking to locate cattle which could be requisitioned for slaughter (reportedly without respect to age, sex, or market readiness).

During the 1965 marketing season, funds were made available for sizable purchases to support the minimum-price levels which had been announced by CFP (the commission for setting minimum-price policy). In that year, the Government actually bought one-third of the rice crop. Thereafter, efforts were made to implement the program through loans to farmers, permitting them to receive price assurances plus the benefits of seasonal increases from the low prices of the harvest season. Even earlier, provisions had been in effect for discounting merchant notes, thus providing credit to buyers who showed evidence of having paid the minimum price for the products represented.

Minimum-price programs for the 1968/69 season are in effect in southern Brazil (including the commercial corn and rice areas of Regions I-IV) for rice, corn, cotton, dry beans, soybeans, castor beans, peanuts, sunflower seed, and manioc. Owing to the difference in harvest seasons, supports are announced separately for such products as corn, rice, and manioc flour in the North and Northeast. Until 1968, the procedure was to announce prices for products delivered in principal consuming centers (such as São Paulo or Recife). Confusion resulted in some cases because of the large discounts from these prices which would naturally have to prevail in production areas to cover transportation and other marketing costs from the production areas to the principal

consuming areas. The 1968/69 minimum prices for southern Brazil were specifically announced for a large number of local marketing centers (centros de convergência). Farmers who deliver to approved facilities at or near these points are entitled to receive loans based on the minimum price (or a percentage of it), subject to relatively minor adjustments for such factors as grade deficiencies. Actual purchases are undertaken through authorized agents of the CFP, usually the local office of the Bank of Brazil. Attitudes of local agency managers are thus extremely important in determining the effectiveness of the program in local areas.

The announced 1968/69 minimum prices at the centros de convergência show remarkably limited variation according to distance from central markets. The two lowest prices for a 60-kilo sack of rough rice (medium grain, types 1 and 2) are NCr\$12.81 and NCr\$12.87 (in Jataí, GO, and Uberaba, MG), while the two highest are NCr\$13.65 and NCr\$13.62 (in Ibirama, SC, and Pedro Osório, RGS; Jacareí, SP, and Itamina, MG). The lowest prices for a 60-kilo sack of type 3 corn (semihard and soft) are NCr\$6.96 and NCr\$7.02 (in Uberaba, MG, and Goiatuba, GO), while the highest are NCr\$7.83 and NCr\$7.75 (in Piraquara, PR, and Ibirama, SC). Minimum prices for producers in relatively remote locations, such as Dourados in Mato Grosso, are thus only 2 to 5 percent below the maximums, even including those in the deficit zones of the major central markets. ^{7/} Whatever the basis for establishing this structure, it may be justified if there is interest in encouraging expansion in the areas assumed to be most responsive to price incentives.

The 1968/69 season minimum prices for rice and corn in the Northeast were announced in December 1967 on the local marketing center basis, and were somewhat higher than the corresponding prices which had been announced several months earlier for the 1967/68 season in the southern part of the country. The time of announcement may have contributed to the higher level, but also the Northeast characteristically receives intermittent shipments of rice and other cereals from the southern States.

Progress in making minimum prices really effective for producers in the North and Northeast has been slower than in southern Brazil. Such information as is available on prices actually received by producers in southern rural areas suggests that geographic variations have been much greater than the variations of the minimum-price schedules. This would not be inconsistent with the objective of assisting farmers to keep title to their crops during the storage period, thus avoiding the necessity of accepting extremely low prices which often prevail during the harvest.

Altogether, it appears likely that aggregate domestic demand for food will continue to grow at a rate around 5 percent a year, that growth of domestic demand for rice may be a little slower and for corn a little faster than this rate, that supplies resulting from any more rapid rate of growth in production can be offered for sale on world markets, and that continuation of

^{7/} In contrast, prices received by farmers for corn in 15 zones of Minas Gerais were reported to have varied during the May-June period of 1968 from a low of NCr\$5.60 to a high of NCr\$9.00 per sack. Prices of rough rice during the same period varied from NCr\$13.00 to NCr\$21.00 (38, table 1).

present policies would avoid supporting domestic prices above levels compatible with the world market situation. Discussion of prices for competing products will not be undertaken at this point, but suffice it to say that no drastic changes in the relative levels of these prices are anticipated.

Rate of Settlement in the Interior

The long continued growth of Brazil's food and fiber output at a rate more or less paralleling growth of domestic demand is largely attributable to expansion of land used in agriculture. This expansion has included a very gradual settlement and use of lands farther and farther westward.

Although large areas of the West and North still remain relatively unknown and unsettled, mapmakers as early as the 16th century already had considerable knowledge of the country's general geography. By the latter half of that century, the pioneering expeditions known as bandeiras were fanning out from São Paulo to search for gold and other minerals in the south, and they shortly began to follow the major rivers and cross and recross the central plains. This soon led to some degree of scattered settlement, but not to rapid population of the interior, even down to the present time. Meanwhile, population and agricultural output have continued to increase in most of the longer established areas, so that the main geographic centers of population and output have moved westward only by small degrees.

The image of an agricultural population that clears land, exploits it until exhausting the soil after a few years, and then moves farther westward is thus a considerable exaggeration, although this may be the pattern for certain individual families. More commonly, lands once settled remain occupied and fields once used for crops are likely to return to crops after some long rotation during which a woodland cover may have been partially reestablished. Individual families may thus engage rather continuously in clearing away trees and brush (which tend to grow rapidly in tropic climate), even without participating in any appreciable westward movement.

Nevertheless, there has been a gradual settlement of the interior, sometimes through privately sponsored colonies or public projects, and more generally through the process of spontaneous colonization. In recent years, of course, the latter has been closely identified with construction of new highways and development of associated infrastructure.

The Belém-Brasília highway illustrates the latter process. It was built as the first major interior connector between the North Region, represented by Belém, and southern Brazil, including not only the vicinity of the new Federal District, but also the entire industrial complex of São Paulo, Belo Horizonte, and Rio de Janeiro. It also serves to open up some of the agricultural lands of Region III, although much of it extends through zones of dubious agricultural potential. Only for 3 or 4 years has the highway been in condition to sustain a more or less uninterrupted flow of truck and bus traffic, but heavy vehicles are already moving north and south in steady streams. This, of course, has meant the opening of gas stations, restaurants, and other service establishments which, together with the improved access to more distant cities, have

broadened the possibilities for marketing farm products and have visibly contributed to growth of agriculture.

In some cases, simply opening a highway seems to have been sufficient to significantly affect agriculture. But continued growth depends upon a much broader development of infrastructure to provide electricity for trading centers and farms; telecommunication systems linking central markets with supply sources; means to permit the flow of materials, credit, and information to farmers; and feeder roads so that farm products can reach main highways economically and expeditiously. Brazil is taking steps to provide this infrastructure, but progress can only be made at a rate adjusted to financial resources and administrative structures and capabilities.

The existence of some privately sponsored colonization schemes, especially in Regions I and II, has already been noted; such zones as those around Londrina and Toledo in Paraná developed with considerable success. Experiences with publicly sponsored projects include failures as well as successes--some participating families have reported bitter experiences. This parallels what has happened in many other parts of Latin America. Where such projects are aimed at improving social equity for seriously disadvantaged families, large and continuous inputs of financial resources and guidance are almost indispensable.

Where the demands for such inputs are the greatest, the problems of adequately providing them are often the greatest also. This applies even within a country the size of Brazil--developing publicly sponsored colonies in Mato Grosso for producers from the minifundia of Rio Grande do Sul may prove somewhat easier than resettling sugarcane workers from Pernambuco in Maranhão, Pará, or Amazonas.

A schematic soil map covering two-thirds of the surface of Brazil, including an area equivalent to Regions III, VI, and VII, excluding the Triângulo of Minas Gerais, indicates where more detailed reconnaissance-level studies could reveal important opportunities for agricultural development under three different levels of management--primitive, semideveloped and developed. ^{8/} The evidence to date suggests that relatively high-level management will be necessary to permit effective use of a large proportion of the unsettled land, especially in latosol areas, but there are also some lands of high natural fertility and other favorable characteristics which can be used to advantage even under relatively primitive techniques. On the basis of evidence from the schematic soil map, a tentative selection was made in 1967 of 10 zones where reconnaissance surveys would be desirable. Six of these 10 zones were in central and southern Mato Grosso, three were in southern Goiás, and one was in Rondônia. Had aerial photography been available, the list might have included two more zones, located in central Maranhão and southern Pará.

The 1964 survey of the Central Plateau concluded that 35 percent of the area was potentially suitable for systems involving intensive crop and

^{8/} The schematic soil map and three interpretive maps have been developed through collaboration by USAID-USDA and Brazilian specialists of the Resources Survey Project, an undertaking of the Division of Soil Science of the Ministry of Agriculture and the Agriculture and Rural Development Office of USAID/Brazil.

livestock production, and that 30 percent of the area was suitable for managed range livestock production (8, p. 27). The report stressed that realization of these potentials would depend upon development of Brazil's fertilizer industry. This condition is now rapidly being satisfied.

Altogether, there seems strong reason to believe that Brazil can continue for a number of years to expand land devoted to agriculture at a rate more or less commensurate with that in the recent past. ^{9/} This means of achieving increases in output is compatible with the traditions and the limited technical knowledge of farmers and farmworkers, and it does not necessarily imply higher costs per unit of output than more intensive production systems, despite assumptions to this effect which seem to permeate the writings of both technicians and journalists. For instance, cases have been cited where direct expenses per unit of output were lower for systems involving relatively primitive techniques than for more intensive and more highly mechanized systems (26, pp. 40-43). Economical production, in short, depends upon careful adjustment of inputs to a highly specific set of circumstances, not on immediate adoption of the most advanced technology known in the area.

By the same token, it does not follow that increased output can best be achieved by exclusive reliance on further expansion of agricultural land. One consideration which should receive careful attention from the viewpoint of public policy is the possible damage to the nation's basic land resources. Much of the land remaining to be settled, as well as much of the land already occupied, is highly subject to erosion. Advanced systems of management must be applied if such lands are to be used without rapid deterioration of productive capabilities. The downstream costs of erosion should also be considered. Forests as well as soils are wasted under the procedures typically associated with spontaneous colonization and primitive cropping systems. High-quality saw logs turn into nothing more than wood ashes because they give way to crops before markets become accessible. The high cost of lumber in most of Brazil should cause much thought before remaining forest resources are slashed and wasted to make way for a low-intensity system of itinerant cropping.

Land Use Alternatives

Economists concerned with agricultural development have devoted many words and pages to debating the degree of response to price incentives which can be expected from producers operating under conditions ranging from traditional to modern. While some analysts almost disregard price as a factor affecting output, others vastly overemphasize it. Of course, the two extremes are about equally unrealistic.

Casual observation of the Brazilian agricultural scene provides adequate basis for asserting that producers do respond to price, as well as to many other stimuli, but according to individual circumstances. For many producers, this boils down to saying that moderate price changes could not be expected to generate much change in production practices or output, especially considering the circumstances under which much of Brazil's corn and rice is grown.

^{9/} Unpublished findings by Dr. Louis F. Hermann of the Economic Research Service, U.S. Department of Agriculture.

This would probably be true even, for example, if the typical morador of central Maranhão were completely free to determine what crops he should plant, and even if he were accustomed to examining production alternatives annually in light of rather complete information. No changes in national or regional price relationships likely to occur in the near future would be drastic enough to lead him to replace rice with another crop, to give up interplanting subsistence crops within the rice, to acquire machinery for cultivating a larger area, to begin applying fertilizer (which is relatively unknown and practically unobtainable in the area), or to take other steps which would have a significant effect on his rice output. Any increase in rice output resulting from a more favorable price situation would most likely come about through attracting more moradores into the area, from some other zone with less favorable opportunities.

A considerable change in rice output as a result of changes in the number of moradores in the area is thus more of a possibility, given time for migration to take place, than changes in production practices and output per family. On the other hand, a rice miller interested in augmenting the supply of rice for his mill might conceivably affect the output of moradores already on his land by importing a new variety of seed and encouraging its use, even in a period with no significant change in price relationships.

The foregoing illustration was chosen partly to call attention to the importance of identifying the various contributors to decisions which affect land use of a given area. Neither the morador nor the landowner has full control over decisions about the use of the land involved, and while each may be concerned with obtaining maximum net returns, their bases of reference differ. For example, if the landowner is also a rice miller who markets the crop of the morador, his considerations will include factors completely extraneous to the actual farming activity. This will lead him to favor using the land for rice production under conditions where the morador might prefer to grow some other crop. On the other hand, he may be too concerned with managing his rice mill and various other activities to work out detailed adjustments in production practices and corresponding changes in tenure relationships which might add to the profitability of the agricultural activity and also to the output of rice. In all such cases, production adjustments will depend upon the combined results of separate analytical approaches by the various parties involved.

The range of realistic production alternatives for producers in many parts of Brazil is relatively limited because of land characteristics, or difficult access to central markets, or for a variety of other reasons. Most perishable crops are grown relatively close to areas of consumption. Several other crops have rather specific environmental needs or are produced only for markets with certain processing facilities. Corn and rice can be grown from one end of the country to the other and shipped from most production areas to markets which can handle almost any given volume. For most producers, corn and rice do not entail a high degree of risk or uncertainty, and the cultural practices ordinarily followed are widely understood. To some degree, these crops can be considered alternatives to use of land for grazing, but they are also in the process under which land is first cropped and then converted to pasture.

In much of Brazil, then, plantings of corn and rice are likely to be influenced more by the availability of capital, labor, and entrepreneurship than by ordinary variations among prices of competing products. Favorable prices for corn and rice in Regions III and VI will result in larger plantings by attracting additional capital, labor, and entrepreneurial interest, but not by encouraging a transfer of land from other crops. There might be some temporary reduction in the area devoted to pasture, but this would have no appreciable effect on livestock production. In this connection, it should be noted that only about 4 percent of the country's total land is used for permanent and temporary crops, and that less than 15 percent is in natural or improved pastures.

In the rice area of Region I, rice and livestock production represent somewhat competitive uses for land, and relative prices of the two products will affect the balance of land use. However, although the balance can be changed to some degree according to relative prices, neither continuous rice production nor a complete shift to grazing use seems plausible for the land involved. Facilities representing large investments are available for irrigating rice, but in general these facilities have been designed with a view to using no more than 25 percent of a given area for rice production in a given year. Using a higher percentage of the area for rice would call for expanding the supply of irrigation water, using much larger inputs of fertilizer, and solving serious weed control problems. Increasing the percentage of a given area in pastures would imply incomplete utilization of the large resources already invested in irrigation facilities.

In Region II, as well as in the corn area of Region I, there is more intense competition among a series of alternative land uses. In São Paulo, particularly, corn and rice come into direct competition with many relatively high-value crops, ranging from horticultural crops and coffee to cotton and oilseeds. There has been some diversion of land from coffee to corn, and more can be expected, but on balance other crops are likely to represent increasingly attractive alternatives to corn and rice production in much of Region II. Nevertheless, there is still opportunity for considerable expansion of total crop acreage here, especially in the western part, as well as elsewhere in the country.

Soybean acreage has been increasing rapidly in the last decade or so in southern Brazil, especially in northwestern Rio Grande do Sul and on a lesser scale in western Paraná and north-central São Paulo. Even in Rio Grande do Sul, however, the area of soybeans has been only about a quarter as large as the area of corn. Some of the soybeans have been planted by wheat growers, who are thus able to harvest two crops from a given field during the same year.

In Regions IV and V, there is much less opportunity for expanding total crop acreage under present technology. Even at present, much of the land used for corn production is too steep and rough to be well suited for the crop. Other large areas are subject to droughts which will continue to impede crop production unless large-scale irrigation projects can be installed.

To summarize, it appears that total acreage of corn and rice can continue to increase, even with increasing competition from other crops, providing favorable prices continue to attract capital, labor, and managerial interest.

Labor, Machinery, and Materials

Labor: The availability of land for settlement or more intensive use is roughly matched by a supply of families ready to move to areas where they can participate in agricultural production as laborers, sharecroppers, tenants, or owner-operators. In general, there has been a continuing flow of families out of the hardship areas of the Northeast, toward the southwest, west, and northwest. Many of these are strictly agricultural laborers, but others have sought to establish themselves as sharecroppers in the Triângulo of Minas Gerais, or as colonists in the interior of Mato Grosso. Migration from the areas of minifundia in northeastern Rio Grande do Sul to western Paraná and southeastern Mato Grosso also deserves mention.

National and State agencies have been created to enumerate, inspect, and assist migrants. Facilities providing food and lodging have been established at strategic points, and various statistics have been recorded of certain aspects of migration flows. In 1958, when there was an exceptional movement from the "drought polygon" of the Northeast, 51,193 men, 16,905 women, and 14,493 children were reported to have passed through Três Rios (State of Rio de Janeiro) on their way south (20). Many of these migrants no doubt became part of the urban concentrations of the major cities, but there are almost certainly still large numbers of unemployed or underemployed ready to seek opportunities in new agricultural areas.

It is also no doubt true that farm operators in many areas sense a shortage of labor, compared with the situation which has often prevailed in the past. One of the first published reports of the new National Sample Survey of Households, conducted quarterly by the IBGE Foundation, is quoted as finding only 228,000 unemployed in the three most southern States of the country, or only about 3 percent of the labor force. Furthermore, less than a tenth of the unemployed were seeking agricultural employment, whereas half of the total labor force was employed in agriculture (35, p. 16).

Machinery: Given the labor situation, it is not surprising that the Ministry of Agriculture has recently taken steps to make farm machinery more readily available for Brazilian agriculture. Several transactions have been arranged for the purchase of grain combines and tractors from countries of central Europe, and a national mechanization plan (PLANAME) has been proposed to encourage the nation's industry to produce more agricultural implements, particularly tractors.

Brazil has plants to manufacture some half dozen or more makes of tractors, ranging from large diesels of 80 or more horsepower to small standard tractors and garden tractors. As is the case for the auto industry, the law requires use of a very high percentage of domestic components, and the price of a tractor delivered to the final buyer is relatively high.

Present national output capacity of the tractor industry is reported to be 19,300 units on a single-shift basis and 33,775 units on a two-shift basis. In 1967, however, the industry only produced 6,219 units, primarily because of limited demand. The total number of tractors in the country is estimated at 70,000 units, or one for each 470 hectares of cultivated land (34, p. 39).

Because tractors of many different makes have been produced or imported in the past, however, large numbers are unserviceable for lack of repair parts. This problem is aggravated by the hard use and lack of maintenance which characterize typical operating conditions.

In early 1968, the base cash price in the São Paulo area for a medium-sized tractor (about 40 horsepower) was equivalent to around U.S. \$4,600, or the value of about 120 metric tons of corn at the announced minimum price. In Iowa, the price of a comparable tractor would probably have been no more than the value of 60 to 80 metric tons of corn. The low price of labor, however, is probably even more of a deterrent to increased mechanization; the highest minimum wage for 1968 was only about U.S. \$35 per month, and the minimum in States remote from industrial cities was about half as much. Efforts to hasten mechanization through special subsidies or other means could obviously create serious unemployment and social welfare problems for groups that already are seriously disadvantaged.

Fertilizer and Lime: Although most of Brazil's long-term expansion of agricultural output is due to increased acreage, the country has had considerable experience with modern inputs and techniques.

São Paulo, in particular, and the south-central States, in general, have been the leaders in use of fertilizer. Total national consumption for 1967 has been estimated at around 1,200,000 metric tons, containing the following quantities of plant nutrients (41):

N	103,000 metric tons
P ₂ O ₅	205,000 metric tons
K ₂ O	137,000 metric tons

Of the total, probably no more than 10 percent was used in the entire North and Northeast (Regions V, VI, and VII).

Brazil has various deposits of phosphates and potassium, as well as a limited installed capacity for producing ammonia. None of these is entirely satisfactory as an economic source of plant nutrients, mainly because of circumstances which contribute to high costs of extraction or processing, and also to some degree because of location and transportation factors. Some of the phosphate deposits are high in iron and aluminum, making them unsuitable for treatment with acid to produce superphosphate, while others are costly to exploit and transport. No potash is produced nationally, and nitrogen output has consisted of a limited amount of calcium ammonium nitrate derived from refinery gases, plus a gradually increasing quantity of sulfate of ammonia as a steel production byproduct. A new \$70 million fertilizer complex, financed in part with a USAID loan, will provide a severalfold increase in the country's capacity for ammonia production, as well as for treatment of phosphates and for preparation of mixed fertilizers.

National production of phosphates and nitrogen has actually declined over the last decade, with the result that nearly 50 percent of the phosphate and more than 90 percent of the nitrogen consumed in 1967 were imported (41). In addition, a considerable share of the phosphates mined in Olinda, Pernambuco,

have to be shipped to ports in the south-central part of the country. A very large share of both imports and coastal shipments enter the port of Santos in São Paulo. This creates a critical problem of congestion, especially between August and October when large volumes of corn are exported through this port.

Fertilizer is commonly thought to be extremely expensive in Brazil, and there is some justification for this thinking. Prices vary considerably with location, however, and a considerable share of the selling price may reflect high costs of internal transportation and handling. Materials representing basic sources of nitrogen and potassium enter the country free of duty under existing tariff schedules, and the same is true for phosphatic materials consumed in excess of a level specified to assure a market for a fixed quantity of national output. Even with high unloading and transfer expenditures, potassium chloride (muriate of potash) has retailed in São Paulo, Minas Gerais, and Guanabara at a lower price than in the United States, whereas nitrogen costs at least a third more and phosphatic materials nearly twice more. At locations more distant from Santos and other ports, prices may be considerably higher, especially since there has been little bulk handling until recently and the commonly used ingredients and mixtures are of relatively low chemical analysis. Thus, the ratios between fertilizer prices and farm prices of corn or rice are considerably less favorable than in the United States.

In many parts of Brazil, fertilizers can scarcely be expected to yield economical results if not preceded by adequate liming, yet the general use of liming materials has almost certainly been much less than adequate. As in the United States before initiation of the Agricultural Conservation Program in 1936, lime supplies of many communities in Brazil are limited to small quantities of hydrated or burned lime, distributed mainly for the building trades. Limited supplies and high costs prevented farmers from becoming more familiar with the benefits of liming, so distribution on a high-volume basis is slow to materialize. Special programs undertaken in Rio Grande do Sul and São Paulo are bringing results, but a large need remains to be met in the country as a whole. One step that should encourage increased use and production of liming materials is the initiation of a series of soil testing laboratories which are beginning to process many soil samples throughout most of the country. The developing fertilizer industry is also showing a readiness to provide information and counsel for its present and prospective clients.

Other Materials: As a large country, Brazil can domestically produce pesticides and other agricultural chemicals which many smaller countries might have to import. The country's main problems are distribution to remote areas and farmers' lack of information which would create a significant demand.

The importance of improved seed has long been publicly and privately recognized in Brazil, with the result that efforts by government agencies to participate directly in production and distribution operations have handicapped the development of an effective private seed industry. The need for such development is now recognized and steps are being taken to channel public efforts toward support rather than competition for the private seed trade. Considerable progress is being made in plant breeding work, establishing seed testing laboratories, training technicians, and initiating a revised national seed law.

Agricultural Credit

Prior to 1964, the Banco do Brasil (Bank of Brazil) supplied some 90 percent of all institutional credit available for agriculture, with the remainder coming from a small number of other national, State, and private banks. Almost all loans were short term and reached no more than 12 percent of all agricultural producers. Since 1964, a much broader program for rural credit has been developed, initiated in considerable measure through funds from USAID loans. This program operates through GECRI, a division of the Central Bank, also established under the Banking Reform Law of 1964. The bank now has broad authority to develop supervised credit, cooperative credit, agricultural credit for the agrarian reform program, finances for minimum prices, and regular commercial credit for agriculture. It operates through contracts with 70 or more participating commercial banks of more than 5,000 local agencies throughout the country.

Since late in 1967, Resolution 69 of the Central Bank has required that 10 percent of important classes of bank deposits be made available for agricultural credit, either by direct use of the originating bank, or by transfer and reallocation through the Central Bank. The resulting funds, plus those from other special sources, have created an unprecedented supply of credit for agriculture. Interest charges on these funds have been fixed at 14 to 18 percent, with no monetary correction to compensate for the considerably higher rate of price inflation (seldom less than 20 to 30 percent annually in recent years). In general, the banking system has done a good job of directing agricultural credit funds into intended uses at the established interest rates, although strong economic pressures must exist for drawing on such lines of credit for nonagricultural purposes, and for negotiating higher rates of payment for their use. This would be possible to the degree that large landowners, with well-established borrowing relationships, are also urban residents with a variety of business interests. In such cases, bank credit directed toward agriculture might in fact substitute in part for private resources diverted to other, more remunerative investment. In an effort to minimize instances of this sort, the Central Bank issued supplementary regulations incorporated in its Resolution 97 of August 1968.

Before Resolution 69, issued in 1967, began to take effect in 1968, the country's total institutional credit for agriculture was equal to only about a quarter of the value of agricultural output. This does not mean, of course, that an additional unit of credit could be expected to produce four additional units of output. For many farmers, the amount of credit available probably represents a rather precise measure of their ability to acquire and use additional purchased inputs, such as fertilizer. In such cases, the amount of credit needed to produce an additional unit of output is likely to be close to 100 percent of the value of the cash inputs needed.

The cash inputs required to produce a cruzeiro's worth of additional output, of course, would normally be something less than a cruzeiro, leaving some margin for management and perhaps for other noncash inputs. In most cases, however, the value of additional output would not represent any large multiple of the value of the needed cash inputs. In other words, additional cash inputs to produce NCr\$1,000 of additional output are more likely to be around NCr\$800 than around NCr\$200.

The total amount of credit needed may be considerably larger than annual cash inputs if part finances inputs with a useful life of 3 to 10 years or more. For example, if a farmer were to borrow NCr\$600 to buy an implement with a useful life of 6 years, plus NCr\$400 for annual seed and fertilizer inputs, his total loan would be NCr\$1,000, but it would finance only NCr\$500 of annual inputs. Over time, such a discrepancy would disappear, but it is significant in planning new or expanded credit programs.

The actual ratio between credit needs and additional output will naturally vary widely between individual farms, types of farming, and areas. For a family with no resources to buy seed, a small amount of credit might generate additional output 20 to 100 times the amount of the loan. On the other hand, the immediate output increase from loans for developing facilities for commercial dairying may be no more than 20 percent of the investment. In general, it seems reasonable that an appropriate mixture of short-term and long-term credit under present Brazilian conditions will require something like a one-to-one ration between additional credit and additional output desired.

Although Resolution 69 and various special credit programs have currently helped ease the demand for agricultural credit, they may not be adequate to meet future needs. If farm output grows at a compound rate of even 5 percent per year, total growth in 10 years will be more than 60 percent. But since the rate of growth will certainly not be equal for all producers, many will have to double their output and new producers will have to establish themselves. Credit for purchase of land, in particular, will need to be more readily available to new and presently disadvantaged producers.

Adoption of Improved Production Practices

Data covering the 1948-62 period showed that crop yields in Brazil were increasing at a rate of less than 0.5 percent per year, and contributed only one-seventh of the total increase in crop output (45, tables 8 and 9). Unpublished data from a continuation of the same research program show a yield index for 24 crops rising at a rate of only 0.1 percent per year from 1947 through 1965. 10/

The latter data provide some support for the thesis that yields are declining as a result of soil exhaustion in some places, while improved practices are bringing higher yields elsewhere. The main contrast is between the index for the State of Minas Gerais, which shows a decline of 0.5 percent per year, and the index for São Paulo, which shows an increase of 0.8 percent annually. More surprisingly, the annual gain for Maranhão appears to be 1.5 percent. Such calculations, of course, are based on crop statistics obtained under extremely difficult conditions and subject to considerable error.

The data for São Paulo, at least, accord with unassailable evidence concerning increased use of fertilizer, improved seed, and other practices which

10/ Data supplied by Dr. Louis F. Herrmann, Economic Research Service, U.S. Department of Agriculture.

contribute to higher yields. In Minas Gerais, there is good reason to believe that soil deterioration is having some adverse effects on yields, while adoption of improved practices has probably been much more gradual.

On the other hand, Minas Gerais is where Brazil's first program of supervised credit and extension was successfully developed through the ACAR organization, which led to formation of the ABCAR national extension system. This system now has affiliate associations in all the States except São Paulo, which has its own extension system operating under the agricultural secretariat. At the start of 1968, the ABCAR system had a total of some 2,200 technicians, 952 local offices, and 140 regional offices. This represents almost a fivefold growth since 1960, when the total number of local offices was only 200. This extension system, however, presently reaches only half the municípios and farmers.

The presence of an extension agent in a município, of course, offers small assurance that improved practices will be adopted and that output will be increased through higher yields. The 2,200 technicians, of whom less than half have the equivalent of a 4-year university course, must try to influence 3 million farm owners, managers, and tenants through very limited channels of communication. They must try to teach the use of complex modern techniques to individuals who may be illiterate and who have often been exposed only to an "axe-and-hoe" type of agriculture. One technician who recently left the system complained that his program called for emphasis on teaching the wise use of lime, but that this material was practically unobtainable in his município. Beyond these problems, the traditions of rural people accustomed to an itinerant agriculture in a country with a vast frontier will be difficult to overcome.

In increasing the use of such materials as fertilizers and pesticides, the extension system will have a strong ally in the agricultural chemical industry of Brazil. In general, distribution systems for these materials seem to be well developed in areas where demand can be found, and increasing efforts are underway to stimulate demand in areas with considerable sales potential.

Considerable progress has been made on studies of the economic aspects of applying fertilizer and other production inputs, but available results provide only a very preliminary indication under the wide variety of soil, climatic, and other environmental conditions throughout Brazil. Experimental results available in 1964 suggested that, in general, application of 75 kilos of P_2O_5 per hectare could increase yields of corn, rice, cotton, coffee, and sugarcane by 10 to 30 percent, compared with no use of fertilizer (1). A nearly universal response to nitrogen has been reported, although much remains to be learned about its use on tropical soils (24). Response to potash is much more limited.

Economic implications of various experiments have also been analyzed in two chapters of a recent book specifically devoted to the culture of corn (12). In chapter XIV, Drs. F. Pimentel Gomes and Humberto de Campos approximate optimum fertilization treatments under assumed price relationships, using data from published and unpublished experiments in the States of São Paulo, Rio de Janeiro, Minas Gerais, Paraná, Goiás, Pernambuco, Espírito Santo, and Rio Grande do Sul. They concluded nitrogen was the most deficient nutrient, and reported that increases of over 1,000 kilos of corn per hectare were sometimes obtained with moderate applications of nitrogen (40 to 70 kilos per hectare).

More generally, they concluded that the most profitable level of fertilization was between 20 and 80 kilos of nitrogen per hectare, even with a fairly adverse ratio between the price of nitrogen and grain. Optimum phosphorus applications in various experiments were estimated between 20 and 90 kilos per hectare, while potash applications appeared economical only in certain locations.

Additional analyses using relatively advanced techniques of determining economic optimums from data produced in the State of São Paulo were presented by Dr. Luiz Torres de Miranda in chapter XV of the same book. He summarized optimum rates of applications according to alternative ratios between nitrogen and phosphorus prices, with results not dissimilar to those reported in chapter XIV of another publication (31). The authors of both chapters noted the extreme importance of liming acid soils, and also pointed to possible needs for other minerals, such as zinc and sulfur.

Simplified approximations of optimum fertilizer recommendations according to soil testing have been developed with the establishment of a group of laboratories now making testing services available to large numbers of farmers throughout the country (4).

Although experiments may narrow down the range of probable economic optimums in fertilizer use under various conditions, it is unreasonable to suppose research results can ever provide final answers for individual farmers and fields. The infinite variety of soil types and management practices are likely to necessitate some final modification of general recommendations.

The relatively small operating unit in agriculture throughout most of the world reflects the large input of individual management needed for even moderately effective results. Unfortunately, agricultural producers in Brazil still have only limited access to even the most rudimentary information needed to make wise decisions. For this reason it would be optimistic to assume that improved practices will be adopted rapidly, accompanied by substantial increases in yields and total output.

Marketing Institutions and Facilities

Imperfect competitive conditions characterize the marketing of corn and rice, as well as other farm products in Brazil. The actual producer may be a sharecropper obligated to sell his product through the person who owns the land or provides financing; this person, in turn, may be able to make effective contact with only one or two buyers. Inadequate roads and transport facilities may contribute to limiting sales alternatives. Farther along in the marketing process, there may be an oligopolistic situation in which a few handlers follow the philosophy of "live and let live." Labor laws and practices, circulation taxes, and many other institutional arrangements limit the free flow of products through marketing channels.

The need for more grain storage facilities has been documented in various studies. One comprehensive study presented a 10-year program which involved a combined investment of some U.S. \$600 million in off-farm grain storage, feed processing, and seed plants (48, especially chapters 10 and 15). Some thorny problems must be solved, however, before such programs can bring desired

results. Given the considerable mobility of grain production in Brazil, locating new facilities at satisfactory points is difficult, and some of the storage facilities already constructed stand idle because expected local production has not materialized or persisted. Risks of this nature are increased when storage facilities are constructed in production areas, but such locations tend to reduce loads on the transportation system and also give farmers more opportunity to hold grain until after the low-price harvest season. Storage on farms would also serve these purposes, but farmers would then have to learn and apply improved methods of limiting storage losses, which can be of considerable magnitude.

Modifications of existing Federal warehousing legislation, which dates back to 1903, are needed if new public storages are to serve effectively. Presently, operators of public warehouses are prohibited from trading in the types of commodities they are storing for others, and they lack the minimum inspection and bonding mechanism to make their warehouse receipts readily acceptable in banking and trade channels.

The flow of products from farm units to market or storage facilities is often impeded by feeder roads connecting with main highways. Improvement of these neighborhood roads has not matched progress on the system of highways linking State capitals. As a result, trucks capable of moving economical tonnages cannot reach many of the farms, especially during rainy periods. In some cases, corn or rice is first moved from the farm by pack animals, and combinations involving animal power, small trucks, and larger trucks are extremely common.

Marketing is delayed when feeder roads are impassable, and the number of possible buyers for a given producer's crop is narrowed. Also, farm enterprise alternatives are restricted to those products which can be marketed over precarious roads, and land is less than fully exploited in locations away from main highways. Thus, even simple improvements consisting mainly of drainage, small bridges, and gravel surfacing would facilitate more economic marketing, as well as more intensive land use.

Agricultural cooperatives could provide growers with better access to main channels of trade and supply. There are many rural cooperatives in Brazil, but few provide the needed combination of receiving, storage, processing, and sales facilities. Development of their capability for marketing milk, eggs, and other livestock products, as well as cereals, will greatly influence future demand for corn.

Much also remains to be done in improving public services for marketing. Needs include revised official grades and standards more in keeping with existing trade practices, effective systems of inspection enforcement, and more adequate systems of collecting and disseminating outlook and other market information.

There are strong reasons for optimism about Brazil's potential in agriculture. Aggregate agricultural production should continue to expand more or less proportionally to the growth of domestic demand. And corn and rice production rates should permit either continuing growth of exports or, in the case of corn, a large increase in supplies for animal feeding.

Preliminary data from Dr. Louis F. Herrmann's study show that aggregate output of 34 agricultural products increased at a compound growth rate of 4.4 percent per year between 1947-49 and 1963-65. A regression fitted to data for the same period showed a growth rate of 4.6 percent per year. Continued output growth of approximately 4.5 percent per year seems a minimum reasonable expectation, providing the present, moderately favorable economic climate continues to prevail. If a 4.5-percent growth rate is a reasonable minimum, a reasonable maximum will certainly not be above 6 percent, which has sometimes been mentioned as a goal.

The Strategic Development Program for 1968-70 specifies the need for a more stable rate of growth in the agricultural sector, elevated to the level of 5 to 6 percent per year. It also suggests that increased productivity, rather than simply an expansion of acreage, should provide some of the additional output. Furthermore, it notes that policies for increasing productivity should avoid encouraging indiscriminate mechanization or other major labor-saving innovations which would tend to reduce employment (30, pp. IV-36,37).

Some Reasonable Projections

Developing reasonable expectations for output of such crops as corn and rice is more complicated than for agricultural output as a whole. Producers throughout the country are familiar with the culture of these crops and have land and other resources sufficient to permit rapid expansion of output. The future may bring somewhat more intense competition for production resources than the past, but there remain possibilities for large increases in planted areas and also in yields. Beyond the growing domestic market there are international markets where the elasticity of demand is high for the output of an individual supplier.

Future exports, of course, will be limited by the capacity of port facilities and the entire mechanism involved in expediting shipments. Private traders, inspection agencies, railroads, highways, storages, and information channels are all involved in the mechanism which is essential for a flow of exports. Bottlenecks at some points can be resolved rather easily, but problems such as port congestions are more likely to require considerable time for solution. Since it appears that Santos and Paranaguã will continue to be the main ports for export of corn, and those of Rio Grande and Pôrto Alegre for rice, and since recent peak export levels have not been attained without various problems, the flow of exports will probably expand only moderately during the next 5 to 10 years. Exports of 800,000 metric tons of rice and 1,500,000 metric tons of corn would be relatively high goals for the 1975-76 average, for example.

If domestic consumption of rice were to grow at around 4 percent a year and if annual exports were to reach 800,000 metric tons, total production in 1975-76 would reach approximately 10 million metric tons, compared with the average 1965-66 production of 6,691,000 metric tons. Such an increase in output would be attainable with an average yield increase of about 1 percent per year, together with an increase of 1,600,000 hectares in planted area, or about the same absolute increase as took place between 1952-54 and 1962-64.

Correspondingly, if domestic use of corn were to grow at around 5 percent a year and if annual exports were to reach 1,500,000 metric tons, total production in 1975-76 would reach about 18 million metric tons, compared with 11,741,000 metric tons in 1965-66. Such an increase in output would require an average yield increase of about 2 percent per year, and an acreage increase of 2,400,000 hectares, or slightly less than the absolute increase between 1952-54 and 1962-64.

The sum of 4 million additional hectares for the two crops represents a 30-percent increase in 10 years and is about the same as the acreage increase during the preceding decade.

All regions can be expected to contribute to acreage increases, but both the rate of growth and the absolute increase will probably be largest in Region III. A schematic distribution of changes in area, yields, and production appears in table 14. The projections which appear in that table are not intended as goals or forecasts, but they are sufficiently realistic to provide a basis for discussing issues involved in attaining or exceeding the projected output levels. 11/

Issues in Attaining or Exceeding Projected Levels

In general, present public policies and programs seem to offer promise of attaining the levels of corn and rice output and export identified as "reasonable projections." The first issue, then, is whether or not these policies and programs will remain in effect. Strenuous efforts have been made in the last 3 years to reestablish a generally favorable economic climate, both for agriculture and for the remainder of the economy. This climate could easily be destroyed, either for the economy as a whole or more specifically for the agricultural sector. The latter could take place, for example, if efforts were renewed for restricting exports and holding food prices artificially low. Direct

11/ The projections in table 14 depend upon no special formula or individual source. Many persons contributed useful thoughts and information which were considered in arriving at the indicated pattern. Special acknowledgment should be made of guidelines provided by Dr. Leo Paschal of the Development Economics Group, Consultores Rodoviários, São Paulo. The aggregate outputs of corn and rice may be compared with earlier independent estimates made by the Center for Agricultural Studies of the Getúlio Vargas Foundation, in a contract study for the Economic Research Service of the U.S. Department of Agriculture. The Vargas Foundation study estimated a 1975 domestic supply of rice and corn at 11,420,000 and 18,990,000 metric tons, respectively (11, p. 92).

price controls may have a place under certain conditions, but they must be applied very cautiously to avoid discouraging output.

The recent emphasis on loans instead of purchases in the administration of the minimum-price program has probably helped raise returns to agricultural producers and stabilize the market without increasing costs of the supported products to consumers. Further improvements in marketing could probably be realized by reviewing warehousing regulations, grades and standards, and procedures for imposing and collecting transaction taxes, such as the existing one identified by its acronym, ICM.

The latter tax, although offering some advantages over its predecessor, the IVC, still represents a heavy burden on consumers and producers. The self-enforcing character of the tax, through which a large share of the proceeds remains with the município where the tax is collected, does not necessarily guarantee a wise distribution of the proceeds. The concession rates established by some States to permit the flow of corn and certain other products into export channels can lead to complications in normal markets.

The issues in maintaining a generally favorable economic climate are not primarily those of determining the costs and benefits of a given investment project or of choosing among several alternative projects, although this may sometimes be involved. Rather, they usually involve the government's constant effort to improve performance in the areas where it must act to establish and control the institutional framework, while avoiding doing what is better left to the private sector. Few of the issues involved are of a purely economic nature, but major economic consequences are likely to result.

There is little evidence to suggest that a government can increase agricultural production simply by exhortation. More tangible actions are needed. However, only the most optimistic would suppose that any government can directly take part in the entrepreneurship of agriculture by detailing the use of resources on individual production units.

As mentioned earlier, farming commonly remains a relatively small-scale activity precisely because the individual entrepreneur has so large a role to play in making decisions. The agricultural producer usually deals with resources and conditions (land, animals, weather, and farm markets) much less standardized than those encountered by the manager of an industrial plant. As a result, a larger input of management per unit of output is needed in agriculture than in industry, and the size of an agricultural unit under a single producer or administrator tends to be smaller. Government can help these individuals by providing them with more adequate information for making their decisions, and by various measures to improve their economic environment. It can scarcely expect, however, to take over the role of production planning for individual farm units.

It would be almost equally rash to assume government could direct agricultural activities which do not take place on farms. Professor R. Schickele has pointed out the two distinct needs which a central government does have to meet. One of these is allocating the use of resources directly subject to government control; the other is managing the institutional framework and planning incentives to encourage maximum performance by the agricultural

sector (37). Meeting both these needs involves the following key steps: First, recognizing the problem; second, assembling the pertinent information and facts; third, identifying alternative solutions; and fourth, comparatively evaluating the alternatives. No government is likely to have personnel and other resources necessary to exhaustively analyze all possible problems. Hence, there is a need for focusing analytical efforts on those problems most deserving of attention. Unless this is done, large inputs of resources are likely to be absorbed in the planning process without significant effect. Also, by the time comprehensive plans which attempt to chart all activities within the large and complex agricultural sector can be developed, they are almost certain to be outdated.

It is only realistic to recognize limitations to any government's capability for executing complex programs effectively. Among major government programs which have operated with relative success in Brazil, it should be noted that two have depended in considerable measure upon the strong organization of the banking system. New agricultural credit has been introduced by means of contracts between the Central Bank and participating national, State, and private banks, while purchase and loan arrangements under the minimum-price program have been administered by the Bank of Brazil under policies established by the CFP. When administration of major programs cannot be entrusted to equally strong organizations, it may be wise to postpone the programs, however valuable they might be if well executed.

Beyond the rather intangible issues involved in maintaining a generally favorable economic climate, there are other, more specific issues involved in attaining the projected levels of output. Some of these issues relate to public programs for making credit available to agricultural producers. At present, public programs have a significant role in directing much of this credit. As noted earlier, Resolution 69 requires banks to direct a share of their lending to agriculture. Certain public funds are also set aside for loans to agriculture, and public resources of the fertilizer fund (FUNFERTIL) are used to subsidize the cost of loans for applying fertilizer.

The first issue relating to credit is again whether or not present programs will be continued and strengthened. They are relatively new, and their development has coincided with a period of generally favorable responses from agricultural producers. Presumably, output would tend to suffer if the new programs were discontinued, although it is very difficult to know what their effects have been. Studies at the farm level are needed to measure more exactly the effect of these programs on production activities and output, and to determine, if possible, to what extent resources made available under the new programs have simply replaced or released private funds. 12/

Another issue involves the availability of agricultural credit for long-term investments, including purchases of real estate. Such investments for expansion and development of the farm unit could help solve problems of welfare as well as human productivity in areas of minifundio. Arguments could also be advanced for using some of the agricultural credit resources for improving rural housing and purchasing household equipment to raise the level of rural family living and to amplify the rural market for urban output.

12/ Some indications for specific instances appear in a report by Donald M. Sorensen and Norman Rask (42).

The issue of broadening agricultural credit is not unrelated to the issue of whether to favor the intensive approach (higher yields) or the extensive approach (more land) to higher output. Economists would expect a minimum-cost solution to involve both approaches, but with different combinations of emphasis. The extensive approach may be the simplest to realize, since it represents a continuation of past trends, and involves no large effort in teaching and learning new techniques. As a minimum-cost solution, however, it will require reasonable distribution of additional public lands, with some assurance of tenure security, and large investments in developing highways and other infrastructure. On the cost side, there is the depletion of forest and soil resources, which has characterized the westward expansion.

If more emphasis is to be placed on the intensive approach, adaptative research and programs of extension education will need to be initiated immediately. Special efforts will also be needed to encourage development of industries and services supplying the agricultural sector. For example, the yield increases projected in table 14 may depend, in part, upon the application of as much as 40 pounds of nitrogen (N) and 40 pounds of phosphoric acid (P_2O_5) per hectare on half the corn acreage in Regions I, II, and III. This would require an additional 140,000 metric tons of both nitrogen and phosphoric acid per year. These additional plant nutrient inputs for corn alone are equivalent to about 130 percent of the total phosphorus and 70 percent of the total nitrogen used in Brazil in 1967. The increased nitrogen needs for agriculture as a whole may correspond reasonably well with the growing production capacity of Brazil's fertilizer industry, but increased imports of phosphatic materials are implied. In any event, there will be a continuing need to coordinate plans for augmenting fertilizer supplies with goals for using fertilizer to increase output.

Although the projections in table 14 have been identified as reasonable, it should be noted that very substantial private and public efforts will be required to achieve these "reasonable" levels of output. To exceed these levels would almost certainly require major public assistance to agriculture.

Need for more rapid expansion of agricultural production might arise, for example, if a national program to help low-income families achieve an adequate level of food consumption were undertaken through expenditure-matching subsidies for food purchases. ^{13/} This would create considerable additional demand for food products in general, including rice, dairy foods, poultry, and pork products, involving use of corn for livestock feeding. Also, local market prices would probably rise to levels which would preclude exports, without substantial direct assistance to subsidize distribution of fertilizer, equipment, and other inputs. In addition, a massive program would be needed to eliminate bottlenecks in marketing and to expand educational and credit assistance to producers. The probable costs and benefits of a food subsidy program deserve study, but the problem is too complex to permit analysis here.

Without such a program, however, an increase in demand for livestock products could easily eliminate the availability of corn for export, even with total production above the projected level. A choice would have to be made between discontinuing exports and finding some means of raising corn production

^{13/} Compare experience with the Food Stamp Program in the United States.

or of limiting its consumption. Increased plantings of grain sorghums in western areas with extended dry seasons would be another alternative to evaluate.

Inasmuch as corn and rice are produced throughout the country and represent a sizable share of total crop area, the issues involved in expanding their production and exports are nearly as broad as those concerning the entire agricultural sector. The issues discussed above can be classified as to those concerned with (1) the general and agricultural economic climates; (2) broad planning in the agricultural sector; (3) the balance between the intensive and extensive approaches to agricultural expansion; (4) rural credit programs; (5) agricultural mechanization and employment; and (6) improving diets of low-income families.

The scope and resources of this exploratory study were too limited to define and analyze all the issues in detail. Moreover, it should be obvious that many of the issues involve considerations which are more political than economic. The study will have served its purpose if it lays a foundation for more detailed analyses. For this reason, much emphasis has been placed on the characteristics and circumstances of the farm operating units, where the primary decisions about production and marketing are made. Detailed knowledge and understanding of the issues are basic to wise policy decisions for the agricultural sector as a whole.

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Table 1.--Percentage distribution of production and area of corn and rice, by region, 1952-54, 1962-64, 1965, and 1966

Region and code		1952-54	1962-64	1965	1966
		Percent			
Production of rice:					
I	Rio Grande do Sul & Santa Catarina	25	23	19	23
II	Paraná & São Paulo	30	21	22	22
III	Central West 1/	18	28	33	27
IV	East Region 2/	16	13	13	14
V	Eastern Northeast	2	3	3	2
VI	Maranhão & Piauí	8	11	9	11
VII	North	1	1	1	1
Brazil		100	100	100	100
Area of rice:					
I	Rio Grande do Sul & Santa Catarina	14	12	11	11
II	Paraná & São Paulo	34	25	26	25
III	Central West 1/	18	30	33	31
IV	East Region 2/	21	16	15	16
V	Eastern Northeast	2	3	2	2
VI	Maranhão & Piauí	9	12	11	14
VII	North	2	2	2	2
Brazil		100	100	100	100
Production of corn:					
I	Rio Grande do Sul & Santa Catarina	26	26	25	26
II	Paraná & São Paulo	35	33	36	37
III	Central West 1/	6	9	9	9
IV	East Region 2/	24	21	20	19
V-VII	North & Northeast	9	11	10	9
Brazil		100	100	100	100
Area of corn:					
I	Rio Grande do Sul & Santa Catarina	22	23	23	24
II	Paraná & São Paulo	32	29	29	28
III	Central West 1/	4	7	8	8
IV	East Region 2/	26	23	22	22
V-VII	North & Northeast	16	18	18	18
Brazil		100	100	100	100

1/ Plus Triângulo of Minas Gerais.

2/ Less Triângulo of Minas Gerais.

Sources: (14 and 28).

Table 2.--Production, area, and yield of rice (rough basis), by region, 1952-54, 1962-64, 1965, and 1966

Region and code		1952-54	1962-64	1965	1966
		Thousand metric tons			
<u>Production:</u>					
I	Rio Grande do Sul & Santa Catarina	800	1,367	1,482	1,340
II	Paraná & São Paulo	954	1,237	1,641	1,243
III	Central West 1/	2/579	1,649	2,521	1,590
IV	East Region 3/	2/499	758	972	817
V	Eastern Northeast	49	162	178	129
VI	Maranhão & Piauí	254	654	708	612
VII	North	34	70	77	71
	Brazil 4/	3,123	5,897	7,580	5,801
		Thousand hectares			
<u>Area:</u>					
I	Rio Grande do Sul & Santa Catarina	293	443	520	446
II	Paraná & São Paulo	722	954	1,176	997
III	Central West 1/	2/384	1,141	1,523	1,224
IV	East Region 3/	2/433	582	687	623
V	Eastern Northeast	43	112	112	87
VI	Maranhão & Piauí	205	449	520	552
VII	North	33	66	82	75
	Brazil 4/	2,123	3,747	4,619	4,005
		Metric tons per hectare			
<u>Yield:</u>					
I	Rio Grande do Sul & Santa Catarina	2.7	3.1	2.9	3.0
II	Paraná & São Paulo	1.3	1.3	1.4	1.2
III	Central West 1/	2/1.5	1.4	1.7	1.3
IV	East Region 3/	2/1.2	1.3	1.4	1.3
V	Eastern Northeast	1.1	1.4	1.6	1.5
VI	Maranhão & Piauí	1.2	1.5	1.4	1.1
VII	North	1.0	1.1	0.9	0.9
	Brazil 4/	1.47	1.57	1.64	1.45

1/ Plus Triângulo of Minas Gerais.

2/ Data for 1953 only.

3/ Less Triângulo of Minas Gerais.

4/ Totals may not add because of rounding and use of 1953 data for certain regions.

Sources: (14 and 28).

Table 3.--Production, area, and yield of corn, by region, 1952-54, 1962-64, 1965, and 1966

Region and code		1952-54	1962-64	1965	1966
		-----Thousand metric tons-----			
Production:					
I	Rio Grande do Sul & Santa Catarina	1,654	2,524	2,992	2,980
II	Paraná & São Paulo	2,177	3,303	4,328	4,147
III	Central West <u>1/</u>	2/367	906	1,148	1,034
IV	East Region <u>3/</u>	2/1,490	2,021	2,363	2,193
V-VII	North & Northeast	533	1,072	1,281	1,017
	Brazil <u>4/</u>	6,227	9,825	12,112	11,371
		-----Thousand hectares-----			
Area:					
I	Rio Grande do Sul & Santa Catarina	1,164	1,764	1,986	2,059
II	Paraná & São Paulo	1,628	2,258	2,592	2,473
III	Central West <u>1/</u>	2/215	562	685	664
IV	East Region <u>3/</u>	2/1,363	1,822	1,951	1,938
V-VII	North & Northeast	818	1,410	1,558	1,570
	Brazil <u>4/</u>	5,171	7,804	8,771	8,703
		-----Metric tons per hectare-----			
Yield:					
I	Rio Grande do Sul & Santa Catarina	1.4	1.4	1.5	1.4
II	Paraná & São Paulo	1.3	1.5	1.7	1.7
III	Central West <u>1/</u>	2/1.7	1.6	1.7	1.6
IV	East Region <u>3/</u>	2/1.1	1.1	1.2	1.1
V-VII	North & Northeast	0.7	0.8	0.8	0.6
	Brazil <u>4/</u>	1.21	1.26	1.38	1.31

1/ Plus Triângulo of Minas Gerais.

2/ Data for 1953 only.

3/ Less Triângulo of Minas Gerais.

4/ Totals may not add because of rounding and use of 1953 data for certain regions.

Sources: (14 and 28).

Table 4.--Area and yields of corn and beans planted singly and planted in association with a second crop in selected States, 1965

State	Area		Yield	
	Planted singly	Planted in association	Planted singly	Planted in association
	Thousand hectares		Metric tons per hectare	
<u>Corn:</u>				
Rio Grande do Sul	1,066	512	1.5	1.3
Santa Catarina	263	145	2.0	1.5
Paraná	519	800	2.0	1.4
São Paulo	1,057	216	1.8	1.0
Minas Gerais	962	910	1.6	0.8
5-State total	3,867	2,583	1.7	1.1
<u>Beans:</u>				
Rio Grande do Sul	171	73	1.0	0.9
Santa Catarina	62	34	1.2	0.8
Paraná	179	468	1.3	0.8
São Paulo	153	107	0.8	0.4
Minas Gerais	185	331	0.7	0.5
5-State total	750	1,013	1.0	0.7

Source: Calculated from data in SEP archives.

Table 5.--Number and area of rice production units (lavouras) in 71 municípios of Rio Grande do Sul, 1950/54 average and 1964/65

Size of planting in hectares	Number of units		Area	
	1950/54 average	1964/65	1950/54 average	1964/65
	<u>Number</u>		<u>Thousand hectares</u>	
Over 1,000	---	1	---	1.7
501 - 1,000	---	25	---	16.5
251 - 500	101	183	34.6	58.1
101 - 250	515	929	77.8	135.5
51 - 100	686	1,434	48.1	99.7
10 - 50	1,598	2,936	29.8	76.5
Subtotal	2,900	5,508	190.3	388.0
2 - 9	3,398	4,006	15.2	19.8
Total	6,298	9,514	205.5	407.8

Source: (21, pp. 88-90).

Table 6.--Percentage distribution of estimated production costs for irrigated rice in the State of Rio Grande do Sul, 1961/62 through 1965/66

Item	1961/62	1962/63	1963/64	1964/65	1965/66
	<u>Percent</u>				
Rent	14.9	16.4	16.3	12.6	7.2
Land preparation	5.6	3.8	5.8	7.6	7.2
Water distribution structures	4.1	3.1	3.6	2.6	2.7
Seeds	7.7	8.1	8.9	10.6	9.1
Fertilizer and spreading	7.4	5.0	5.2	6.7	8.0
Irrigation (fuel, machinery and labor)	15.4	14.0	10.5	19.3	19.9
Harvest	8.2	9.6	10.2	11.2	10.1
Transport to thresher and drier	6.5	7.0	6.7	7.6	11.4
Taxes	8.4	7.8	6.7	6.6	6.5
Machine maintenance	6.3	6.8	7.5	2.6	2.7
Interest charges	3.7	8.0	6.3	6.1	8.1
Other (including sacks, roads, fences, buildings, pesticides, insurance, etc.)	11.8	10.4	12.3	6.6	7.1
Total	100	100	100	100	100

Source: (21, p. 74).

Table 7.--Storage capacity of warehouses and silos in the State of Rio Grande do Sul, by ownership and type of service, 1964

Ownership	General warehouse	Other public	Private	Total 1/
	-----Thousand metric tons-----			
Federal	24	5	4	33
State and municipal	345	16	8	370
Cooperative and producer	---	3	602	604
Business	14	32	1,489	1,536
Total 1/	383	57	2,102	2,543

1/ Totals may not add because of rounding and inclusion of 782 metric tons of business-owned storage, unclassified as to type of service.

Source: (6, table 59).

Table 8.--Physical inputs for corn production under two techniques of cultivation in Itapeva, São Paulo, 1964/65

Inputs	: Using animal power, : : on properties of : : 11 to 19 hectares : : Using tractor power, : : on properties of : : 26 to 60 hectares	
	:-----Days per hectare-----	
Man labor	: 18.6	: 7.4
Animal work	: 9.0	: 0.2
Tractor work	: ---	: 1.9
Moldboard plow	: 2.4	: ---
Disc plow (3 discs)	: ---	: 0.5
Wood harrow	: 0.5	: ---
Disc harrow	: ---	: 0.5
Lime spreader	: ---	: 0.1
Hand planter	: 2.5	: ---
Tractor planter	: ---	: 0.2
Animal-drawn cultivator	: 2.6	: ---
Disc cultivator	: ---	: 0.2
Cart or wagon	: 0.4	: 0.5
Corn sheller	: 0.1	: 0.1
	:-----Kilos per hectare-----	
Seed	: 17	: 17
Fertilizer	: 89	: 180
Lime	: ---	: 306
	:-----Sacks per hectare-----	
Sacking and twine	: 24	: 25

Source: (9, tables 13, 14, 17, and 28).

Table 9.--Labor and power inputs, by operations, for corn production under two techniques of cultivation in Itapeva, São Paulo, 1964/65

Inputs	Using animal power, for properties of 11 to 19 hectares	Using tractor power, on properties of 26 to 60 hectares
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Source: (9, tables 13 and 14).

Table 10.--Storage capacity of warehouses and silos in the States of Paraná and São Paulo, by ownership and type of service, 1964

Ownership	General warehouse	Other public	Private	Total ^{1/}
	<u>Thousand metric tons</u>			
Federal	824	72	1,044	1,940
State and municipal	578	50	242	870
Cooperative and producer	---	5	531	535
Business	3,131	275	1,805	5,210
Total ^{1/}	4,533	402	3,621	8,555

^{1/} Totals may not add because of rounding.

Source: (6, tables 53 and 55).

Table 11.--Physical inputs for upland rice production under two yields in
Region III, 1965/66

Inputs	Yield of --	
	900 to 1,200 kilos per hectare	1,200 to 2,000 kilos per hectare
	<u>Hours per hectare</u>	
<u>Man labor:</u>		
Land preparation	22	22
Planting	10	4
Cultural operations	116-160	75
Harvest	100-180	20
Total	248-372	121
<u>Tractor work:</u>		
Land preparation	6	6
Planting	---	2
Harvest	---	2
Total	6	10
<u>Animal work:</u>		
Cultural operations	---	20
Harvest	5	---
Total	5	20
<u>Use of equipment:</u>		
Plow	4	4
Harrow	2	2
Planter	---	2
Cultivator	---	20
Cart	5	2
Combine	---	4
<u>Materials:</u>	<u>Kilos per hectare</u>	
Seed	80	150
Ant killer	0.5	1
Insecticide	0.1	0.4
	<u>Sacks per hectare</u>	
Sacking	20	30

Source: (26, pp. 8-10).

Table 12.--Comparative data on number and area of units in State of Maranhão, censuses of 1940 to 1960, and IBRA registrations, 1966 and 1967

Item	Census data			IBRA data	
	1940	1950	1960	1966 tabulations	1967 forecast
-----Thousands-----					
<u>Units enumerated:</u>					
Less than 10 hectares	81	75	230	---	---
10 to 99 hectares	8	9	20	---	---
100 to 999 hectares	5	9	10	---	---
1,000 or more hectares	0.5	1.9	1.9	---	---
Total	95	95	262	62	80
<u>Units by status of person responsible:</u>					
Owner	17	25	31		
Manager	7	3	4		
Renter, paying in money	}12	5 {	40	1/13	
Renter, paying in product			48	2/	
Occupant, public lands	}44 {	50	126	3/12	
Occupant, private lands			12		
<u>Area of units enumerated:</u>					
Less than 10 hectares	0.18	0.19	0.52	---	---
10 to 99 hectares	0.35	0.35	0.66	---	---
100 to 999 hectares	1.23	3.10	3.20	---	---
1,000 or more hectares	1.25	5.90	3.83	---	---
Total	3.01	9.54	8.21	15	19
<u>Area in crops:</u>					
Permanent		0.01	0.03	---	---
Temporary		0.32	0.86	---	---
Total		0.33	0.89	0.87	---

1/ Identified as arrendatarios, some of whom may have made payment in product.

2/ The report shows 40,000 parceiros, some of whom may have been "autonomous."

3/ Primarily those on private lands, based on estimate from table 58 of (18).

Sources: (16, tables 1, 2, 5, and 6; 17, tables 1, 2, and 8; and 18, tables 1 and 58).

Table 13.--Quantity and value of Brazil's corn and rice exports, 1950-67

Year	Rice (rough basis)		Corn	
	Quantity	Value	Quantity	Value
	Thousand metric tons	US\$1,000	Thousand metric tons	US\$1,000
1950	803	n.a.	11.7	n.a.
1951	118.1	n.a.	295.2	n.a.
1952	---	---	---	---
1953	---	---	---	---
1954	---	---	11.7	n.a.
1955	2.5	n.a.	80.1	n.a.
1956	102.4	9,725	---	---
1957	0.3	32	---	---
1958	51.6	5,625	---	---
1959	9.8	1,083	---	---
1960	0.4	28	9.9	408
1961	150.8	13,169	4.4	180
1962	43.7	4,748	---	---
1963	---	---	699.2	29,504
1964	12.4	851	62.3	2,928
1965	236.8	23,765	559.7	27,915
1966	289.3	33,320	627.1	31,804
1967	---	4,700	430.4	22,053

Sources: (14 and 29).

Table 14.--Projected changes in area, yield and production of corn and rice, 1965-66 to 1975-76, including 1955-56 average for area

Region:	Area				Yield		Production		
code	1955-56 : average :	Actual : increase :	1965-66 : average :	Projected : increase :	1975-76 : projected :	1965-66 : average :	1975-76 : projected :	1965-66 : average :	1975-76 : projected :
	Thousand hectares				Metric ton per hectare		Thousand metric tons		
Rice:									
I	347	136	483	136	619	2.95	3.25	1,411	2,010
II	862	224	1,086	224	1,310	1.30	1.55	1,442	2,020
III	1/513	1/861	1,374	861	2,235	1.50	1.65	2,055	3,680
IV	1/468	1/187	655	187	842	1.35	1.50	895	1,360
V	57	43	100	43	143	1.55	1.70	153	240
VI	246	290	536	290	826	1.25	1.25	660	1,030
VII	40	38	78	38	116	0.90	0.90	74	100
Brazil:	2,533	1,779	4,312	1,779	6,091	1.55	1.70	6,691	10,440
Corn:									
I	1,270	753	2,023	500	2,523	1.45	1.75	2,986	4,430
II	1,871	662	2,533	600	3,133	1.70	2.05	4,237	6,400
III	1/307	1/367	674	700	1,374	1.65	1.90	1,091	2,610
IV	1/1,418	1/526	1,944	500	2,444	1.15	1.25	2,278	3,060
V	729	355	1,084	250	1,334	0.70	0.70	783	930
VI	181	239	420	250	670	0.75	0.75	321	500
VII	35	24	59	50	109	0.75	0.75	45	80
Brazil:	5,811	2,926	8,737	2,850	11,587	1.35	1.55	11,741	18,010

1/ Approximate.

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